FEDERATION OF NIGERIA

ANNUAL REPORT

OF THE

AGRICULTURAL RESEARCH

FOR THE YEAR 1956-57

NINEPENCE NETT

NCP
RAM
MM

1958

LAGOS: FEDERAL GOVERNMENT PRINTER

COMMONWEALTH MYCOLOGICAL INSTITUTE
3 JUL 1958

FOREWORD

The over-all objective of the Federal Department of Agricultural Research is to ensure a plentiful and cheap supply of food to the people of this country. With an ever growing population on the one hand and the danger of soil exhaustion on the other, the importance of agricultural research to the economy of Nigeria cannot be over-emphasised. Everything possible is therefore being done to develop new techniques for the more efficient production of food and export crops and encouraging progress has been made both in this respect and in the control of plant diseases and pests and the maintenance of soil fertility.

2. Of particular interest to farmers is the success achieved with chemical control of the yam beetle. Good progress has also been made in the development of the Federal Rice Research Station, Badeggi. On the whole the year under review has been one of consolidation and continued progress in all fields of agricultural research.

3. Unfortunately, the work of the Department of Agricultural Research continues to suffer from the shortage of scientific staff. Agricultural research is a slow process which calls for much patience but those who undertake it have the satisfaction of knowing that the fruits of their labours will benefit their country for many generations to come. We look therefore to suitably qualified young Nigerian scientists to come forward to help in this all-important work. It is hoped that the Federal Government Emergency Science Training Centre on which the Government places great hopes will help to speed up the training of the scientists of the future.

KOLAWOLE BALOGUN,
Federal Minister of Research and Information

CONTENTS

	Page
Foreword by Hon. Minister	1
Staff List	5
Report by Director	7
Sectional Reports:	
Chemistry	13
Botany	14
Maize Research Scheme	22
Rice Research Scheme	22
Plant Pathology	29
Entomology	34
Publications	47
Organisation Chart	48

Staff List as at 31st March, 1957 (including Officers of the Maize Research Scheme and Rice Research Scheme)

DEPARTMENT OF AGRICULTURAL RESEARCH

Director of Agricultural Research :

Dr J. M. Waterston, Ph.D. (Edin.), B.Sc., A.I.C.T.A.
(Proceeded on leave 18-12-56)

Assistant Director of Agricultural Research :

Vacant

Records Officer :

2 vacancies

Secretary-Typist :

Vacant

Executive Officer :

M. I. Ntephe

Principal Research Officers :

2 vacancies

Senior Specialist Officers :

G. S. Cotterell, A.R.C.S. (Lond.), D.F.C., F.R.E.S. .. *Senior Entomologist*
2 vacancies

Specialist Officers :

J. L. Gregory, B.Sc. (Sheffield), D.A.S. (Cantab.), D.T.A. (Trinidad) (Resumed duty 28-12-55) .. *Entomologist*

J. E. Y. Hardcastle, B.Sc. (Dunelm), D.A.S. (Cantab.), D.T.A. (Trinidad) (Resumed duty 13-2-57) .. *Botanist*

S. R. Chant, B.Sc. (Edin.), D.A.S. (Cantab.), D.T.A. (Trinidad) (Resumed duty 26-5-56) .. .. *Plant Pathologist*

B. D. A. Beck, B.Sc. (Manch.), D.A.S. (Cantab.), D.T.A. (Trinidad) (Resumed duty 19-10-56) .. *Botanist*

J. A. R. Bates, B.Sc. (Wales), A.R.I.C. (Proceeded on leave 20-2-57) .. .. *Chemist*

K. M. Harris, B.Sc. (Wales), D.A.S. (Cantab.), D.T.A. (Trinidad) .. .. *Entomologist*

A. W. Waitt, B.Sc., D.A.S. (Cantab.), D.T.A. (Trinidad) (Assumed duty 8-8-56) .. .. *Botanist*

J. K. C. Dunlop, B.Sc., A.R.T.C., A.R.I.C., D.A.S. (Cantab.), D.T.A. (Trinidad) (Assumed duty 8-8-56) *Chemist*

5 vacancies

Analyst :

Vacant

Technical Officers :

A. O. Bamtefa . . . . . *Technical Officer (Agriculture)*

F. O. Iwenjora . . . . . *Laboratory Technologist*

J. A. Marden, Dip. Hort., Kew Cert. (Assumed duty 6-2-57) . . . . . *Technical Officer (Agriculture*

W. A. Porter, N.D.A., C.D.A. (Assumed duty 23-2-57) *Station Manager*

2 vacancies

MAIZE RESEARCH SCHEME

Senior Scientific Officer :

Dr W. R. Stanton, B.SC. (Reading), PH.D. (Lond.) . . *Geneticist*

Scientific Officers :

R. H. Cammack, B.SC. (St Andrews) . . . . *Mycologist*

Ing. C. L. M. Van Eijnatten I.k. (Assumed duty 30-4-56) . . . . . *Plant Breeder*

RICE RESEARCH SCHEME

Senior Agricultural Officer :

Vacant

Specialist Officer :

G. Jenkins, B.SC., D.T.A. (Trinidad) . . . . . *Botanist*

VISITING SPECIALIST

Dr V. F. Eastop, PH.D. . . . . *Taxonomic Entomologist*

Annual Report on the Department of Agricultural Research, Federation of Nigeria, for the Year 1956-57

REPORT OF THE DIRECTOR

INTRODUCTION

There were no major changes in policy as outlined in the Annual Report for 1955-56 during the period under review. The main lines of investigation followed those of the previous year and included the improvement of food crops and the control of plant diseases and pests. Details will be found under the appropriate sectional headings which follow this report. The shortage of scientific staff continued as in previous years to be the chief limiting factor to the progress of agricultural research. As a result the Department reached less than 50 per cent of the authorised establishment.

STAFF

The Department lost the services of Mr C. A. Thorold, Principal Research Officer, who retired in February 1957, after completing 27 years in H.M. Overseas Civil Service, of which eight were spent in Nigeria ; and two specialist officers, Mr J. T. Davey, Entomologist, who left Nigeria after nine years' service in September 1956 and Mr W. D. Clayton, Ecologist, who was transferred to the Northern Region Department of Agriculture in November 1956. These losses were partly offset by the recruitment of two new plant breeders and one chemist. The total specialist establishment (including the Maize and Rice Research Schemes) was 26 of which only 14 posts were filled.

The authorised establishment of Senior Staff at the beginning of the year and the actual strength at 31st March, 1957, are given in the following table :—

Department of Agricultural Research	*Authorised*	*Actual*
Director of Agricultural Research	1	1
Assistant Director	1	—
Principal Research Officers	2	—
Senior Specialist Officers	3	1
Specialist Officers	13	8
Analyst	1	—
Records Officers	2	—
Technical Officers (Agriculture)	3	2
Laboratory Technologists	2	1
Executive Officer, Grade I	1	1
Secretary-Typist	1	—
Station Manager	1	1
Maize Research Scheme		
Senior Scientific Officer	1	1
Scientific Officers	2	2
Rice Research Scheme		
Senior Agricultural Officer	1	—
Specialist Officer	1	1
	36	19

The corresponding position for junior staff at March 1957 showed a total number of 3 vacancies in an establishment of 180 as follows :—

Establishment	*Authorised*	*Actual*
Chief Clerk	1	1
Assistant Chief Clerk	1	1
First Class Clerks	7	5
Second and Third Class Clerks	21	17
Clerical Assistants	7	6
Telephone Attendants	3	3
Messengers	10	9
Assistant Technical Officers	13	5
Senior Agricultural Assistants, Grade II	5	4
Agricultural Assistants, Grade I	6	4
Agricultural Assistants, Grades II and III	37	33
Field Overseers, Grades I and II	48	47
Library Assistant	1	—
Assistant Photographer	1	1
Artisans	4	2
Laboratory Attendants	6	3
Driver Mechanics	3	2
Temporary Field Staff	5	5
Temporary Clerical Staff	1	1
	180	149

PROGRESS OF RESEARCH WORK

The primary objective of the Department's research programme is to ensure a plentiful and cheap supply of food to the population. The last census taken in 1953 revealed the population in Nigeria to be over 31 millions, with an annual rate of increase of 2.1 per cent which if maintained will result in a population double its present size before the end of the century. There is no immediate cause for alarm in this figure provided that the annual rate of Nigeria's per capital income growth maintains itself in real terms above the 3 per cent projected by the Economic Mission in 1954. However, the prospect of a population increase of this magnitude when viewed against an agricultural background of low yields and soil fertility is not one for complacency, and it is of vital importance to the nation that steps are taken to ensure that the production of staple food crops keeps pace with population growth.

The improvement of communications which is being planned by Government will provide access to new areas for agricultural development. Additional land alone, however, will not be sufficient without the development of new techniques which will permit a more intensive use of the land and more efficient production of both food and export crops. It is against this background that the main objectives of the Department of Agricultural Research are at present framed.

Fundamental studies are planned on problems concerned with the maintenance of soil fertility and the production of food crops. Over 20 million tons of cassava and yams are produced annually ; but this figure could be doubled if means can be evolved for the application of the results of research in the field. Rice production is estimated at around a quarter of a million tons but is also capable of rapid expansion as has already been demonstrated at Abakaliki where its recent introduction over the past 20 years in rain-fed swamps has been received with spectacular success.

The Headquarters for Federal Agricultural Research are based on Moor Plantation, Ibadan, where it is planned to have four Specialist Sections, *viz.*, Botany, Chemistry, Entomology and Plant Pathology, each in charge of a Principal Research Officer. The specialist officers work as a team. Thus, the root crop team is composed of 2 Plant Breeders from the Botany Section, 2 Plant Pathologists from the Plant Pathology Section and one Entomologist from the Entomology Section. The Principal Research Officers are responsible for the administrations of their sections and supervise the work of their respective specialists.

The research facilities at Moor Plantation are at present being shared with the Western Region Department of Agriculture and negotiations were continued with the Western Region Government with a view to the re-apportionment of the area to permit the implementation of the Federal Department's projected expansion of research facilities which are embodied in the Economic Programme for 1955-60.

Facilities for rice research are being developed at the Federal Sub-Station, Badeggi. The Station is still under construction and an account of research in progress is given elsewhere in this report.

Investigations on Soil Fertility.—During the past four years the Chemistry Section has been closely associated with a 20-acre soil fertility experiment to determine the effect of grass and bush fallow, as well as continuous cropping on the yield of maize and yams. The results for the last year—the first in which data of test crops were obtained—were disappointing and on the advice of Rothamsted Research Station it was decided to abandon the experiment. A new grass fallow experiment has been laid down with a view to investigating the effect of various grasses on soil fertility, in particular the soil organic matter.

The Ecologist carried out further useful vegetation surveys in the forest-savannah boundary near Ibadan, and from Olokemeji to Iwo, as well as a reconnaissance of the soils and vegetation of Ibadan Province.

Improvement of Food Crops.—Progress continued to be made with cassava breeding and some promising high yielding strains have been selected for further trial. The recruitment of an additional botanist also enabled a start to be made on the improvement of the yam crop, as well as an investigation on other root crops of potential value such as sweet potatoes.

In addition to the work on cassava and yams, research on maize and rice improvement was carried out under two Colonial Development and Welfare Schemes and is described elsewhere in this report.

Attention is also being paid to health protective foods such as tomatoes and citrus. Some progress has been made in recent years in selecting improved varieties, and there is a considerable field of investigation awaiting the arrival of a Horticulturist.

Control of Plant Diseases and Pests.—Progress was made in the study of cassava mosaic virus which causes a widespread disease of one of the main sources of carbohydrate food in Nigeria. The Plant Pathologist and the Plant Breeder worked as a team to evolve suitable techniques for the production of new disease-tolerant types of cassava.

The Plant Pathologist also determined the cause of a serious seedling wilt disease of cocoa due to the fungus *Phytophthora palmivora* and evolved satisfactory control measures which have now been adopted in the cocoa-growing regions. Other diseases studied included a suspected virus disease of yam, citrus gummosis and pineapple fruitlet brown rot.

More effective precautions against the entry of new plant diseases and pests became possible on the arrival of a Plant Quarantine Officer in February 1957.

Research on the control of yam beetles (*Heteroligus meles* Billb.) by the Entomologist, in both the Western and Eastern Regions, using gamma BHC dust as a treatment of seed yam continued to give promising results with satisfactory economic returns. Yam farmers are becoming interested in the possibilities of chemical control and the project will be continued.

Valuable assistance was received from Dr. V. F. Eastop, an entomological taxonomist from the British Museum (Natural History) visiting West Africa, under Colonial Development and Welfare (Research) Scheme No. 725, who carried out a survey of aphids and white-flies which are important both as plant pests and as vectors of plant diseases. Preliminary transmission experiments with white-flies have indicated that the species of *Bemisia* on cotton, cassava, tomato and *Euphorbia heterophylla* may be one species. Further studies are planned as soon as an additional Entomologist is available, to determine the relationships of the *Bemisia* species which are vectors of cassava mosaic and the leaf curl diseases of cotton and tobacco.

Progress was made by the Entomologist studying cereal pests in the Northern Region in the assessment of damage and the determination of the life histories of sorghum midge and lepidopterous stem-borers.

There was a considerable amount of desert locust activity in Nigeria during the year. There was no directional movement nor any signs of sexual maturity. As there was no immediate danger of egg-laying no control measures were attempted.

AGRICULTURAL TECHNICAL COMMITTEE

The Third Meeting of the Agricultural Technical Committee of the Council of Natural Resources was held at Ibadan in May. The main topic discussed was the organisation of rice research with special reference to co-ordination and liaison with other research workers in West Africa. The meeting was also attended by representatives from interested research organisations in Sierra Leone and Ghana.

INTER-TERRITORIAL RESEARCH

A notable contribution to a more effective liaison in inter-territorial research was made by the establishment of a West African Standing Advisory Committee for Agricultural Research. The first meeting was held at Accra on 11th April, 1956, and was attended by representatives of the Departments of Agriculture and Forestry from Nigeria, Ghana, Sierra Leone and the Gambia, as well as by delegates from the appropriate Faculties of the University Colleges of Nigeria and Ghana. A successful Soils and Plant Nutrition Conference was subsequently held under the aegis of the Committee at Ghana University College on 26th-27th March, 1957, and was attended by twenty-seven delegates, nine of whom were from Nigeria.

Meetings of the Management and Technical Committees of the West African Cocoa Research Institute and the West African Oil Palm Research Institute were regularly attended and the research needs of all regions kept in view. Contributions to research continued in spite of a shortage of staff. Good progress was made at the Nigerian Sub-Station of the West African Cocoa Research Institute at Ibadan in developing methods for the more efficient control of outbreaks of cocoa swollen shoot virus. Valuable assistance was also received from this Institute in dealing with problems of virus diseases of economic plants other than cocoa, and also from the West African Institute for Oil Palm Research on problems connected with crop nutrition.

COLONIAL DEVELOPMENT AND WELFARE SCHEMES

West African Maize Research Scheme.—The work of breeding and selection continued along the same lines as in previous years and included yield trials of top-cross hybrids and in-bred lines. Pathological work included studies on the inheritance of rust resistance and several new fungus diseases which have recently come into prominence in the course of the Unit's investigations.

Nigerian Rice Research Scheme.—Building construction work was resumed on the posting of a Federal Works Superintendent to Badeggi. Good progress was made on the construction of staff quarters, offices and laboratory. The experimental fields were also improved. Sixteen field trials were conducted to test new rice varieties, fertilizer requirements and cultural methods. Detailed observations were maintained on 247 rice varieties which included 30 new introductions.

Particular attention is being paid to the standardisation of grain type in the different ecological zones for rice culture with a view to the improvement of milling quality. In addition, a producer-buyer-consumer survey is being planned to determine the major grain type preferences.

DISTINGUISHED VISITORS

The Department was honoured by the following distinguished visitors:—H.E. Sir James Robertson, Governor-General of the Federation; H.E. Sir John Rankine, Governor of the Western Region; The Hon. Obafemi Awolowo, Premier, Western Region; H.E. M. Biros, Governor-General of Dahomey, and Sir Eric Ashby, Vice-Chancellor of Queen's University, Belfast.

VISITING SCIENTISTS

Dr Walter Carter, Senior Entomologist of the Pineapple Research Institute, Honolulu, Hawaii, visited Nigeria in July to advise on disease and pest control measures for cocoa and pineapples. His recommendations for capsid control are being studied by the West African Cocoa Research Institute and his advice that agronomic investigations be started immediately on pineapples is being followed up by the Western Region Department of Agriculture.

Dr J. C. F. Hopkins, Director-designate of the Commonwealth Mycological Institute, also visited Nigeria in July to advise on the control of tobacco leaf curl. In his report he recommended that the problem should be resolved by an intensification and extension of agronomic methods of control as at present being practised, with special reference to plant hygiene in seed beds, the elimination of suspected alternate host plants from the vicinity of seed beds and tobacco fields and by guarding against successive plantings in close juxtaposition. Fundamental research with special reference to alternate host plants of the virus and the specificity of the white-fly vector was also recommended.

In connexion with the latter, the Department's root crop research team which is already investigating white-flies in relation to cassava and other crops has now widened its terms of reference to include tobacco.

Further research on white-flies was stimulated by the visit of Dr V. E. Eastop, a specialist on the taxonomy of this group of insects and aphids, who was based at Ibadan from March to July 1956 and at Samaru from August to September. He spent two weeks in the Gambia in September to October and toured north-eastern Nigeria from October to December. He also visited the Eastern Region of Nigeria and the Southern Cameroons during January and February 1957.

INTERCHANGE OF VISITS BY SPECIALISTS TO NEIGHBOURING TERRITORIES

Mr J. K. C. Dunlop represented the Department at the West African Soils and Plant Nutrition Conference organised by the West African Standing Advisory Committee for Agricultural Research, at Ghana University College from 26th-27th March. Other delegates from Nigeria included Dr V. A. Oyenuga, University College, Ibadan, Dr P. B. H. Tinker, West African Institute for Oil Palm Research, Benin, Messrs B. O. E. Amon and A. J. Smyth, Western Region Department of Agriculture, Messrs W. D. Clayton, H. Irving and N. Middleton, Northern Region Department of Agriculture and Mr P. Tuley, Eastern Region Department of Agriculture.

Mr J. T. Davey, Entomologist, continued on secondment to the Research Mission of the Provincial International Committee for Locust Prevention in the French Sudan until September, 1956, when he left the Nigerian service. Dr V. E. Eastop, Entomologist (British Museum) remained based in Nigeria throughout the year and continued his studies of Aphidae and Aleyrodidae. He also visited the Gambia. Dr W. R. Stanton, Senior Scientific Officer visited the Department of Agriculture, Pretoria, Union of South Africa in October and also the Institut Francais d'Afrique Noir at Dakar.

Visiting scientists from outside territories included Sir William Slater, Secretary, Agricultural Research Council; Professor R. L. Wain, London University; Dr J. C. F. Hopkins, Director, Commonwealth Mycological Institute; Dr Walter Carter, Senior Entomologist, Pineapple Research Institute, Honolulu, Hawaii; Dr Warren Weaver, Vice-President for Natural and Medical Sciences, Rockefeller Foundation; Dr Robert S. Morrison, Director of Biological and Medical Research, Rockefeller Foundation; Mr T. N. Hoblyn, East Malling Research Station; Dr E. J. Hewitt, Long Ashton Research Station; Dr Ford Milam, Agricultural Attache, American Embassy, Monrovia, Liberia; Mr F. Pinder, Director of Agriculture, Liberia; Mr H. Hylam, F.O.A., representative U.S.A. Technical Aid Programme; Mr D. Rhind, Secretary for Agricultural Research, Colonial Office; Messrs D. Jordan, R. Q. Granford and M. G. A. Hart of the West African Rice Research Station, Rokupr, Sierra Leone; Mr T. Jones, Acting Director of Agriculture, Sierra Leone; Messrs J. Bowden and K. Agble and Miss E. Waller, Department of Agriculture, Ghana; Mr F. Hagenzieker, University College, Ghana; Mr A. Pickles, Secretary, West African Standing Advisory Committee for Agricultural Research, and Dr F. L. Hendrick, Scientific Secretary, C.C.T.A.

ACKNOWLEDGEMENTS

Grateful acknowledgement is again made to the Commonwealth Agricultural Bureaux for invaluable assistance with many technical problems. It is also a pleasure to record our indebtedness to the Directors of the Research Stations at Rothamsted, East Malling and Long Ashton for their continued interest and help with West African problems.

J. M. WATERSTON,
Director of Agricultural Research

24th December, 1957.

SECTIONAL REPORTS—CHEMISTRY

STAFF

J. A. R. Bates.....*Chemist*

Experiment on Fallows and Restoration of Soil Fertility.—The experiment described in the Annual Report for 1952-53 (Part II, page 12) was abandoned on the advice of Rothamsted after taking the first test crop in 1956. The number of replications was reduced from ten to six. Maize (var. Mexico I) was grown on three of the replications and white yams (*Dioscorea rotundata*) on the remainder. Each plot under cropping was split into four for fertilizer trials of N, P, NP, and Nil. The P treatment was 2 cwt of superphosphate per acre, applied at planting time; the N treatment was 4 cwt of ammonium sulphate per acre, applied in two parts, one about a week after planting and the other two months later. All fertilizers were placed on the tops of the ridges and lightly covered with soil.

Rainfall was unusually low during the growing season and a drought in May retarded the crops. The yields obtained in the test crop are summarised in Table 1.

Table 1.—Mean Yield (cwt/acre) of Early Maize and Yams taken as a Test Crop following 3 Years Continuous Cropping Compared with 3 Years Fallow (Cenchrus and Centrosema)

Treatment		*P*	*N*	*NP*	*Nil*	*Mean*
Early Maize						
Following Cropping	(±0.83)	11.7	10.0	13.3	9.6	11.1±0.69
Following Fallow	(±0.64)	14.5	12.9	15.1	13.0	13.9±0.53
Weighted Mean	(±0.51)	13.4	11.8	14.4	11.7	12.8
Yams						
Following Cropping	(±3.33)	53.3	54.5	55.5	56.2	54.9±2.94
Following Fallow	(±2.58)	55.0	56.0	52.6	58.4	55.5±2.28
Weighted Mean	(±2.04)	54.4	55.4	53.7	57.6	55.3

Statistical analysis of the experiment showed plot errors to be very high amounting to 19.4 per cent for maize and 18.1 per cent for yams. The corresponding whole plot errors were 32.1 per cent and 31.9 per cent. The only significant effect was that of superphosphate on early maize.

A new grass fallow experiment has been laid down with a view to investigating the formation of organic matter under different types of cover.

Laboratory Work.—This is at present being confined to an investigation of the nature and properties of soil organic matter. A new separation has been worked out dividing the soil into nine fractions, seven of which contain organic compounds. Standard techniques are being applied to these and the humic fractions isolated are to be separated into their components. The ultimate aim of this work is to identify the organic compounds present which contribute most to the structure-building properties of soil organic matter.

BOTANY

STAFF

B. D. A. Beck .. .. *Botanist*
W. D. Clayton .. .. *Ecologist*
A. W. Waitt .. .. *Botanist*
A. O. Bamtefa .. .. *Technical Officer*

In marked contrast to the previous year, rainfall was extremely low. There was more rain than usual in March and the planting of arable crops was not delayed but growth and establishment were severely affected by the dry weather in May.

METEOROLOGICAL DATA FOR MOOR PLANTATION, IBADAN, 1956

Month	*Rainfall*			*Mean RH %* 0900 *GMT*	*Temperature*		
	Inches (Days)	*Cumulative Total (inches)*	*Average 1946-55 (inches)*		*Mean Max. °F* 0900 *GMT*	*Mean Min. °F* 0900 *GMT*	*Mean Temp. °F* 0900 *GMT*
January ..	0.01 (1)	0.01	0.37	78.2	91.8	66.7	79.3
February ..	0.89 (6)	0.90	1.16	80.0	94.4	69.3	81.9
March ..	6.00 (11)	6.90	2.81	82.7	91.2	69.0	80.1
April ..	5.08 (6)	11.98	5.94	80.5	91.3	69.0	80.2
May	2.28 (11)	14.26	6.39	83.2	89.9	67.5	78.7
June ..	6.17 (11)	20.43	7.21	84.7	86.9	66.9	76.9
July	2.69 (11)	23.12	5.25	87.1	81.1	66.0	73.6
August ..	0.88 (9)	24.00	3.15	89.5	80.0	65.0	72.5
September ..	2.83 (16)	26.83	8.00	85.6	85.3	66.8	76.5
October ..	4.40 (10)	31.23	7.59	81.1	88.2	67.7	78.0
November ..	2.63 (5)	33.86	2.28	78.9	91.0	68.3	79.7
December ..	0.83 (2)	34.69	0.23	85.1	90.9	64.5	77.7
Total ..	34.69 (99)	34.69	50.38	83.5	88.5	67.2	77.9

Records of water loss from a free water surface in an evaporation tank 2 metres square and 0.6 metres deep established at Moor Plantation have shown little variation over the past three years.

RECORDS OF EVAPORATION FROM A FREE WATER SURFACE AT MOOR PLANTATION, IBADAN, 1954-1956

Month	*Evaporation (Inches)*		
	1954	1955	1956
January	3.39	3.13	3.65
February	3.97	4.08	4.08
March	5.92	4.42	4.86
April	4.82	4.65	4.76
May	4.17	4.72	4.24
June	3.63	4.42	3.84
July	2.91	3.08	3.20
Carried forward	28.81	28.50	28.63

RECORDS OF EVAPORATION FROM A FREE WATER SURFACE AT MOOR PLANTATION, IBADAN, 1954-1956—*continued*

Month	*Evaporation (Inches)*		
	1954	1955	1956
Brought forward	28.81	28.50	28.63
August	1.96	2.46	2.15
September	2.97	2.81	2.86
October	4.06	5.65	4.12
November	5.12	4.03	3.73
December	3.85	3.55	3.81
Total	46.77	47.00	45.30
Mean	3.90	3.92	3.77

FOOD CROPS

Cassava (B. D. A. Beck).—The collection and classification of Nigerian cassava varieties was continued. Acquisitions made during the year included sixteen Manihot interspecies hybrids from Amani, which are being multiplied vegetatively and tested for resistance to Nigerian strains of cassava mosaic virus. One hundred and eighty-seven clones were established of which 40 have shown no symptoms of mosaic infection after five months in the field when surrounded by infected plants and supporting a high white-fly population.

As in 1955-56, the variety 53101 was consistently the highest yielder in trials at Moor Plantation and gave a yield equivalent to 14 tons per acre after one year's growth. The yields of varieties 43083, 55125, 32024, 37063 were lower than that of 53101, but the differences were not significant.

The trials contained high-branched varieties which do not form a shade canopy and low-branched types which form a completely closed canopy early in their development. Considerable differences in the weed flora beneath the two types of cassava were noted. Underneath high-branched varieties there was a complete ground cover of weeds, principally *Tridax procumbens* with *Brachiaria deflexa* and occasional sedges, whereas varieties forming a completely closed canopy had a weed flora restricted to occasional stands of *Spigellia anthelmia*.

Investigations into the effect of type of planting material on the yield of cassava were continued. As in 1955-56, it was demonstrated that plants grown from cuttings taken from the base of the main stem gave a significantly greater yield than plants grown from cuttings from the top of the main stem or from lateral branches. For greater uniformity in cassava trials only cuttings from the base of the main stem are now used.

The study of the effect of length of growing period on the yield of cassava was continued. A two-year trial with the variety 37065 showed that the mean number of tubers per stand did not increase with age. The growth rate of tubers reached a maximum at nine to twelve months and then decreased sharply. There was no significant increase in tuber size from twelve to 21 months, but between 20 and 21 months there was a second period of rapid growth, so that at 24 months, when the experiment ended, the two-year-old plants gave a greater yield than the one-year-old. Both periods of rapid growth occurred in the dry season. The tubers of this variety did not store well in the ground after eighteen months.

A trial with the variety 53101 showed that after two years' growth 20 per cent of the tubers had rotted in the ground and that the total yield of two consecutive one-year plots was greater than that of one two-year plot. Neither of these two varieties can be regarded as suitable for long-term cultivation.

Trials with the variety 55123 showed that growth of the tubers was continuous for the two-year period of the trial. Two-year-old plots gave a yield equivalent to 36 tons per acre which is believed to be the highest yield of cassava recorded in Nigeria. Some of the tubers were rather woody but excellent gari was made from them. The tubers contained 25 per cent starch (measured as gari produced from fresh tubers) whereas tubers of 37065 of equivalent age contained only 18 per cent starch.

Over a thousand clones derived from a series of inter-varietal crosses within the species *M. utilissima* were multiplied vegetatively and established in the field. The study of the inheritance of the variety characters of cassava was continued. All clones were susceptible to cassava mosaic virus. The initial selection of high yielding mosaic-tolerant clones was carried out after a nine-month growing period. A further selection based upon the number of tubers per stand was made to eliminate the slower maturing strains of cassava.

Several selections, notably from 37065.12, were most promising. The highest yielding selection gave a mean yield of 18 lb. per stand.

The hybridization of cassava varieties for selection of high yielding mosaic-tolerant clones and the investigation into the inheritance of variety characters in cassava were continued. Over 29,000 controlled pollinations were made between September and December 1956 but only 18,000 viable seed were harvested.

The production of interspecies hybrids of cassava with *M. glaziovii* and back-crossing interspecies hybrids to cassava was commenced for selection of clones resistant to cassava mosaic.

Investigations into the hydrogen cyanide content of cassava tubers were continued. A slight tendency for the cyanide content of the tubers of some varieties to increase with age was noted.

A joint series of investigations on the effect of cassava mosaic virus on the growth and yield of cassava has been commenced with the Federal Plant Pathologist.

Observations over an 8-month period on a selected cassava variety have shown that primary infection with cassava mosaic virus significantly reduces the yield but no significant differences between stem and petiole weights or hydrogen cyanide content of peeled tubers were recorded. There was a highly significant positive correlation between leaf area and yield in healthy plants but no such correlation was found in infected plants when symptom expression was at its maximum. At this time there is also a significant difference between the leaf areas.

The carbohydrate: nitrogen ratio of leaves taken from infected plants was higher than in comparable leaves taken from healthy plants althouth the actual percentages of carbohydrate and nitrogen were less. This may be an indication of a greater rate of breakdown of carbohydrate and nitrogen since the respiration rate of leaves from infected plants kept in the dark was found to be significantly greater than that of comparable leaves from healthy plants.

Yams (A. W. Waitt).—A survey is being made of yams grown in Nigeria. With the co-operation of the Regional Departments of Agriculture, questionnaires have been sent to each Agricultural Division with a view to obtaining general information on yam agronomy as well as data on the botany, agronomy and ethnology for each variety.

The varieties detailed in the questionnaires will be collected and grown under uniform climatic conditions. In this way the elucidation of varietal synonyms should be achieved. This collection will be subjected to selection and will provide a source of breeding material.

The yam collection at Moor Plantation at present consists of 74 varieties of the following species from within Nigeria:—*D. rotundata*, *D. cayenensis*, *D. dumetorum*, *D. alata* and *D. esculenta*.

Preliminary work has shown the possibility of separating varieties by means of vegetative characters which can be mathematically defined. Also important in the separation of varieties are physiological characters.

It is not yet known by what factor or factors flowering is controlled in the yam plant This will need to be investigated before a breeding programme can be introduced. Flowering and non-flowering varieties are at present being grown in the yam collection at Moor Plantation and their growth and development studied. Chemical treatments will be given to non-flowering types in an attempt to induce flowering.

Of the varieties which produce flowers only a few produce seeds in any quantity. From a preliminary investigation it appears that when the seed is harvest ripe it is not germination ripe, *i.e.*, the embryo is immature. Certain conditions of type and duration of storage are required before germination will take place. The best germination percentages of varieties of *D. rotundata* and *D. dumetorum* tested were obtained by planting the seeds on the surface of charcoal.

Another experiment laid down this year is intended to increase our knowledge on growth, germination and development of the yam sett. The heads, middles and bottoms are being studied separately.

Other investigations include uniformity, staking and variety trials.

Tomato Collection (B. D. A. Beck).—Recent acquisitions from Italy are most promising, the variety Prezioso being outstanding. Trials at the beginning of the wet season, in which a spray mixture of 0.5 per cent Perenox and 0.1 per cent D.D.T. was applied twice weekly, have demonstrated a considerable increase in yields of marketable fruit. Sprayed plots of the variety Prezioso gave a mean yield of 980 g. of marketable fruit per plant compared with 430 g. per plant from unsprayed controls.

The method of establishing plants in the field has been greatly improved during the past year. From previous experience in Trinidad it was thought that exposure to full sunlight would cause scorching and death of seedlings if they were transplanted too young. However, with soil blocks, in which the root system is not disturbed at transplanting, seedlings can be put in the field and exposed to full sunlight at four to five weeks without damage. This has solved a difficult problem since the available greenhouses were either too hot or too dark or both to allow the development of strong seedlings after the plants were five weeks old.

Sweet Potatoes (A. W. Waitt).—A few non-flowering varieties of sweet potato are being grown for observation at Moor Plantation. Further varieties are to be introduced, after suitable quarantine percautions, from other countries with a view to improving this crop in Nigeria.

Other investigations include uniformity, staking and variety trials.

Tomato Collection (B. D. A. Beck).—Recent acquisitions from Italy are most promising, the variety Prezioso being outstanding. Trials at the beginning of the wet season, in which a spray mixture of 0.5 per cent Perenox and 0.1 per cent D.D.T. was applied twice weekly, have demonstrated a considerable increase in yields of marketable fruit. Sprayed plots of the variety Prezioso gave a mean yield of 980 g. of marketable fruit per plant compared with 430 g. per plant from unsprayed controls.

The method of establishing plants in the field has been greatly improved during the past year. From previous experience in Trinidad it was thought that exposure to full sunlight would cause scorching and death of seedlings if they were transplanted too young. However, with soil blocks, in which the root system is not disturbed at transplanting, seedlings can be put in the field and exposed to full sunlight at four to five weeks without damage. This has solved a difficult problem since the available greenhouses were either too hot or too dark or both to allow the development of strong seedlings after the plants were five weeks old.

Sweet Potatoes (A. W. Waitt).—A few non-flowering varieties of sweet potato are being grown for observation at Moor Plantation. Further varieties are to be introduced, after suitable quarantine precautions, from other countries with a view to improving this crop in Nigeria.

Citrus (J. M. Waterston).—The trials of suitable rootstocks for sweet orange and grapefruit planted in 1931 have continued to show a decline in yield. It now appears evident that under Ibadan soil conditions and when no fertilizers are used budded trees reach their peak around 13-15 years of age with profitable life of 25 years.

The most promising rootstock for Ruby Blood sweet orange based on the number of fruit produced appeared to be mandarin, followed by sour orange and tangerine as shown in Table 2.

TABLE 2.—MEAN ANNUAL YIELD OF RUBY BLOOD SWEET ORANGE EXPRESSED IN NUMBER OF MARKETABLE FRUITS PER TREE, FROM THE 4TH TO 24TH YEAR FROM PLANTING, AT MOOR PLANTATION, IBADAN

Rootstock	*No. of trees*	*Fruits per tree*
Mandarin	3	1,100
Sour Orange	6	891
Tangerine	3	864
Acid Lime	6	785
Sweet Orange	6	721
Grapefruit	6	403
Shaddock	6	331
Hybrid Lemon	6	223
All Stocks	—	665

Spacing : 70 trees per acre.

Records of weight of fruit harvested were maintained only during the past nine years. The figures in Table 3 show the marked superiority in this respect of both mandarin and tangerine.

TABLE 3.—MEAN YIELD OF RUBY BLOOD SWEET ORANGES EXPRESSED IN BOXES (73.5 LB) OF MARKETABLE FRUIT PER TREE FROM THE 16TH TO 24TH YEAR FROM PLANTING, AT MOOR PLANTATION, IBADAN

Rootstock	*No. of trees*	*Boxes per tree*	*Fruit per box*
Mandarin	3	5.5	213
Tangerine	3	5.4	193
Sour Orange	6	3.8	194
Acid Lime	5	3.1	187
Grapefruit	4	2.3	171
Sweet Orange	6	2.2	214
Shaddock	5	1.1	211
Hybrid Lemon	5	0.8	206
All Stocks	—	3.0	199

Spacing : 70 trees per acre.

In view of the results obtained from mandarin and tangerine as rootstocks for sweet orange a further trial was established in 1952 at Ibadan. Named varieties of tangerine and tangelo hybrids (grapefruit x tangerine) were used as well as authentic material of rough lemon, and all trees received dressings of fertilizer. Yield data at the 4th year from planting, shown in Table 4, indicate that Cleopatra tangerine and Lake tangelo are promising.

TABLE 4.—YIELD OF A NIGERIAN SWEET ORANGE VARIETY AGEGE I EXPRESSED IN WEIGHT AND NUMBER OF FRUIT PER TREE AT THE 4TH YEAR FROM PLANTING AT MOOR PLANTATION, IBADAN

Rootstock	*No. of trees*	*Fruit per tree*	*Boxes per tree (73.5 lb)*
Tangerine (Cleopatra)	8	233	1.6
Tangelo (Lake)	8	153	1.2
Rough Lemon (S. Leone)	8	127	0.7
Sweet Orange (Agege I)	8	106	0.7
Tangelo (Sampson)	8	77	0.5
Sour Orange (Trinidad)	8	21	0.1
Sour Orange (Local M.P.)	8	19	0.1
Sweet Orange—Unbudded (Agege I)	8	—	—
All Stocks	—	92	0.6

Spacing : 70 trees per acre.

The most promising rootstock for grapefruit (an un-named seedy variety) based on the number of fruits produced in the 1931 trial proved to be sour orange followed by mandarin as shown in Table 5.

TABLE 5.—MEAN ANNUAL YIELD OF GRAPEFRUIT (UN-NAMED SEEDY VARIETY) EXPRESSED IN NUMBER OF MARKETABLE FRUITS PER TREE, FROM THE 4TH TO 24TH YEAR FROM PLANTING AT MOOR PLANTATION, IBADAN

Rootstock	*No of Trees*	*Fruits per Tree*
Sour Orange	6	715
Mandarin	2	650
Tangerine	4	597
Grapefruit	6	563
Acid Lime	6	491
Sweet Orange	6	467
Hybrid Lemon	6	345
Shaddock	6	274
All Stocks	—	513

Spacing.—70 trees per acre.

Records of weight of fruit harvested were maintained only during the past nine years. The figures in Table 6 show the marked superiority of tangerine and sour orange in this respect.

Table 6.—Mean Yield of Grapefruit (Un-named Seedy Variety expressed in Boxes (60.0 lb) of Marketable Fruit per Tree from the 16th to 24th Year from Planting, at Moor Plantation, Ibadan

Rootstock	*No of Trees*	*Boxes per Tree*	*Fruit per Box*
Tangerine	4	10.2	73
Grapefruit	6	6.4	70
Sour Orange	6	6.3	87
Mandarin	2	5.7	75
Sweet Orange	6	3.1	87
Acid Lime	6	3.0	85
Hybrid Lemon	6	2.5	72
Shaddock	4	1.1	84
All Stocks	—	5.0	78

Spacing.—70 trees per acre.

No further investigations on grapefruit were undertaken, but a rootstock trial for Lisbon Lemon was established at Ibadan in 1953. All trees received dressings of fertiliser. Yield data at the 3rd year from planting, shown below, give promising indications of the superiority of Cleopatra tangerine and Lake tangelo :—

Table 7.—Yield of Lisbon Lemons expressed in Weight and Number of Fruits per Tree at the 3rd Year from Planting, at Moor Plantation, Ibadan

Rootstock	*No. of Trees*	*Boxes per Tree* (76 *lb*)	*Fruit per Tree*
Tangerine (Cleopatra)	8	1.6	436
Tangelo (Lake)	8	1.6	422
Sour Orange (Trinidad)	8	1.3	366
Sour Orange (Local M.P.)	8	1.0	269
Rough Lemon (S. Leone)	8	0.8	243
Sour Orange (California)	8	0.8	232
Sweet Orange (Agege I)	8	0.7	211
Tangelo (Sampson)	8	0.7	200
All Stocks	—	1.1	297

Spacing.—70 trees per acre.

Gummosis, caused by the fungus *Phytophthora parasitica*, caused serious damage to the rough lemon stocks. Three trees died as a result of attack by this pathogen in the first year of the trial and another in the second year. Rough lemon does not appear to be a suitable stock for lemons in the forest zone.

The results of the citrus work to date suggest that it may be possible to find a suitable substitute for sour orange rootstock in the mandarin-tangerine groups. In the past, sour orange has proved a satisfactory rootstock for sweet orange but its general use is no longer recommended in view of its susceptibility to *tristeza*, a virus disease which has been shown to occur in other parts of West Africa, though not yet reported in Nigeria. Trials are being conducted with Cleopatra tangerine as a *tristeza*-tolerant rootstock for acid limes in Ghana and these should provide advance information of value to Nigeria.

Coffee (B. D. A. Beck).—Routine maintenance of the coffee plots was carried on. The highest yielding type was *Coffea excelsa*, planted in 1935, which gave the equivalent of 3,000 lb per acre of fresh cherry. The highest yielding member of the robusta group was robusta *ex* Ghana, planted in 1932, which produced the equivalent of 2,400 lb per acre of fresh cherry. Stringent crop sanitation measures have greatly reduced the infestation of the berries with *Stephanoderes hamperi*, the coffee berry borer.

Kola (B. D. A. Beck).—Analysis of ten years' yield data from intraspecies hybrids of *Kola nitida* planted on Moor Plantation in 1937 has shown that there is a considerable range of variation in yield between families. Yields from hybrid families derived from female parents grown from white nuts increased in the order white nut female x white nut male, white nut female x pink nut male and white nut female x red nut male. These yield increases, with the introduction of the inherently high yielding red nut gene complex into the hybrid, reach a maximum in the crosses between trees grown from pink nuts and trees from red nuts. The second highest yielding families are derived from the reciprocal of this cross.

Self-pollination and back-crossing of the hybrids to their parents have confirmed that hybrids obtained by crossing two white nut trees produce only white nuts when selfed or back-crossed to their parents. Both pink and red nut colour appear to be dominant to white as well as controlled by separate genes.

ECOLOGICAL INVESTIGATIONS

(W. D. Clayton)

The early part of the year was devoted to work on the forest-savannah boundary near Ibadan. Previous work at Fada had traced the course of succession from an impoverished thicket type of vegetation to secondary forest. At an area on the Omi River some ten miles east of Ibadan it was possible to trace the retrogression of this thicket type to a savannah vegetation dominated by the grass *Imperata cylindrica*. The savannah had here formed a small "island" of about one square mile within the rain forest zone. Further investigations were made along the forest-savannah boundary from Olokemeji to Iwo in order to compare the vegetation along this boundary with the sequence already observed within the rain forest.

The remainder of the year was occupied in an ecological reconnaissance of the soils and vegetation of Kabba Province, particularly that part of the Province lying to the west of the River Niger and underlain by rocks of the Basement Complex—about 5,000 square miles. The vegetation of much of the Province is of the derived savannah type, dominated by *Daniellia oliveri* with which are associated many other species including the oil palm, *Elaeis guineensis*. In the higher rainfall region stretching westwards from Kabba, there are large areas of rain forest. To the north of the derived savannah is a belt of dissected country and escarpments, bearing a woodland dominated by *Uapaca somon*. Further north again lay southern guinea savannah dominated by *Daniellia oliveri* and associated with various other species including *Prosopis africans*.

It soon became apparent that the soils of the Province were too complex to map on such a small scale but that they were clearly related to the geomorphology. An attempt was therefore made to map geomorphological units. On the Basement Complex rocks there are two main surfaces, at 1,300 feet and 800 feet respectively, each bounded by an escarpment or a belt of dissected country and the former surmounted by hill blocks representing the remnants of a still higher surface. On Cretaceous sediments the 800-foot surface could be clearly distinguished, together with at least two lower surfaces flanking the Benue River.

During February a short visit was paid to Wushishi near Zungeru (Niger Province) to carry out a vegetation survey of about 50 square miles of land on the bank of the Kaduna River. The vegetation, which could be mapped from aerial photographs, consisted of *Daniellia/Prosopis* coppice and farmland on the better drained soils, *Daniellia/Terminalia macroptera* open woodland on the poorly drained soils, and open grassland on the fairly flooded soils.

MAIZE RESEARCH SCHEME R471

STAFF

Dr W. R. Stanton	*Geneticist*
R. H. Cammack	*Mycologist*
C. L. M. Van Eijnatten	*Plant Breeder*

The following is a summary of the work of the Maize Research Unit during the current year. Detailed accounts are given in the Unit's Annual Report.

Breeding.—An analysis of the 1954 and 1955 trials in the southern guinea savannah zone and in the northern half of the secondary forest zone showed that the variety Mexico 5 exceeded Mexico 1 in yield and that both outyielded local varieties. In the more humid forest areas, however, the yield of local varieties was not exceeded. The indigenous maize varieties of the Benin-Warri area appear particularly well adapted to wet conditions.

The variety Sicaragua proved very variable in yield and is being discarded for this reason as well as on account of its lack of acceptability to local consumers.

A synthetic of Martinique lines is being tested as a possible second season maize crop. This group has the shortest maturity time of the Trinidad series and evidence from the 1955 trials has shown the superiority of the Martinique sub-group over others in the series in the second season.

Breeding work was continued on the production of "polysora" resistant inbreds and their top crosses to local varieties and other exotics, for testing in the trials section. Some of the East African Agriculture and Forestry Research Organisation lines which show high *Helminthosporium* resistance were also multiplied. Routine assessment of breeding lines and greenhouse testing of hybrids involving the transfer of "polysora" resistance from Mexico 13 inbred to a Lagos White x White Tuxpan cross was carried out. No information is yet available on the yielding ability of crosses of the partial inbreds (S_2) which have been produced.

Pathology.—In addition to the routine assessment of breeding lines and greenhouse testing of hybrids for resistance to maize rust, *Puccinia polysora*, the Mycologist compiled a check-list of local maize pathogens. Taxonomic problems were presented by a series of leaf-spots which were formerly attributed to *Cochliobolus heterostrophus* and which may be due to *Helminthosporium sativum*. These fungi may be found frequently in association. Investigations were continued also on a pellucid ring spot of unknown origin.

Samples of ears in husk from all plots of a variety trial were sent to the West African Stored Products Research Unit for analysis of pre-harvest insect infestation. It was found that the level of infestation by lepidopterous larvae did not vary from variety to variety but highly significant differences were obtained in the counts of weevils (*Calandra* sp.)

RICE RESEARCH SCHEME R514

STAFF

J. E. Y. Hardcastle	*Botanist-in-charge*
G. Jenkins	*Plant Breeder*
J. K. C. Dunlop	*Chemist*

The scheme was strengthened by the posting of a Chemist to the Rice Research Station. It is hoped to post additional plant breeders when these can be recruited. Close liaison was maintained with the West African Rice Research Station at Rokupr, Sierra Leone.

BUILDING PROGRAMME

Construction work was resumed on the posting of a Federal Works Superintendent to the Station, and good progress had been made on the construction of three senior staff quarters as well as an office and laboratory by the end of the year.

The grounds around the office, laboratory and all quarters have been cleared and levelled. The whole of the cleared frontage to the Station was planted with *Cynodon dactylon* which has become well established and has responded to regular mowing. Neem trees have been planted to improve the appearance of the Station and to provide shade.

THE EXPERIMENTAL FIELDS

Monthly mean figures for maximum and minimum temperatures, relative humidity and rainfall for the year, recorded at the Meteorological Station No. 0906/00C, are given below. Average rainfall figures for Bida Aerodrome (based on 27 years' readings) are given for comparison.

METEOROLOGICAL DATA FOR RICE RESEARCH STATION, BADEGGI, 1956

Month	*Maximum Temperature (O° F)*	*Minimum Temperature (O° F)*	*Relative Humidity Per Cent*	*Rainfall (Inches)*	*Average Rainfall Bida (Inches)*
January	91.9	60.4	50.2	Nil	0.12
February	95.6	70.3	64.6	Nil	0.32
March	93.9	73.6	73.0	2.97	1.04
April	95.5	74.5	75.3	1.70	3.04
May	93.8	73.2	67.5	2.55	6.01
June	87.6	72.0	73.9	6.34	7.41
July	84.4	72.5	77.7	4.49	8.12
August	84.3	71.5	77.9	2.49	8.54
September	86.6	71.3	79.5	12.76	10.08
October	89.9	73.3	77.3	4.23	4.32
November	93.2	70.3	69.1	0.10	0.31
December	91.5	65.2	55.7	Nil	0.01
Total	—	—	—	37.54	49.32

The minimum temperatures at Badeggi are seldom below 70° F. The low minimum temperatures and low relative humidity in January and December were due to the harmattan.

Rainfall for the year was below average and poorly distributed resulting in correspondingly poor rice crops in the non-irrigated areas. Rainfall was well below average in May and the greater part of the rain fell on one day (1.20 inches). A fortnight's drought occurred at the end of June, and rainfall in July and August was so much below average that the water supply of the Badeggi irrigation scheme had to be rationed. No rain fell from mid-November 1956 until the end of the year. Despite this the water table on the fadama was observed to be high in February. There was no flooding of the experimental fields in 1956.

All the experimental fields were ploughed after the end of harvesting in January 1956 when the ground was still moist. In late January and February, the land dried out on the surface but was still moist underneath as was evidenced by the heavy weed growth after mid-February. Disc harrowing to remove this growth and produce a tilth began in mid-March and continued until the end of May to destroy the re-emergent weed growth. Heavy rain on 30th May put an end to all mechanised operations. Much hand weeding was necessary at transplanting. The lack of continuous irrigation during June, July and August prevented effective submergence control of weeds and this increased the amount of hand weeding.

On the basis of this experience it was decided to delay the initial ploughing the following dry season in order to reduce the weed growth between ploughing and harrowing. At the end of January 1957 it was found that the surface of the clay soils was too hard for the disc plough to penetrate. Irrigation water supplied for a few days made ploughing possible but the emergent weed growth in mid-February was as heavy as ever despite the absence of rain. To take advantage of the persistently high water table it was planned to complete harrowing by 30th April and to drill seed on non-experimental areas, at a depth of 2-3 inches during the first week in May. Drilling in 1955 had produced surprisingly good yields despite the fact that the varieties used were not adapted to mechanical drilling.

In the 1956 season the experimental fields were given overall dressings of 1 cwt./acre of ammonium sulphate and 1 cwt./acre of superphosphate. Although there was no pronounced response to superphosphate in the 1955 indicator trials, it was thought wiser to include a phosphate dressing until such time as the nutrient status of the soils was established.

Water was supplied by the Irrigation Department, Bida, to the fields continuously at a constant head and the Station was responsible for the internal distribution of the water. Steps were taken also to ensure adequate distribution of all drainage water.

The arrangement worked well within the limitations imposed by the shortage of water. It was not possible to maintain a continuous head or even a continuous flow in the distributary channels serving the experimental fields. Supplies are bound to fluctuate in May, June and July even in a normal year and such fluctuations may become more severe as the irrigable land of the Badeggi Scheme becomes fully occupied.

In view of this some lines of research included in the original programme, *e.g.*, investigations into the duty of water, effect of water depth, and soil responses to continuous irrigation, will probably have to be carried on elsewhere where a continuous water supply can be guaranteed.

Since it had not proved possible to remove all the large termite mounds which remained in the experimental fields during the previous dry season the contoured strip layout first imposed in 1954-55 had to be retained. This form of layout has several disadvantages, notably the impossibility of siting more than a few of the blocks of any one experiment continuously (this undoubtedly gave rise to the high coefficients of variation found in some of the year's trials), and the difficulty of applying irrigation water with accurate timing to any individual experiment without temporary channelling. Another problem is that the removal of a termite mound exposes a large core of coarse sand with very low fertility. The only solution, which involves much labour, is to remove the coarse sand to 2-3 feet in depth and replace it with the surrounding soil.

Some 50 acres of clay soil in the experimental area have now been brought under 90-100 per cent control, leaving some 20 acres of sandy soil needing further levelling. The 50 acres have been laid out in rectangular blocks, thus permitting all the field trials scheduled for 1957 to be laid down without scattering of blocks.

THE RESEARCH PROGRAMME

The research programme consisted almost entirely of field experimentation and observation. There were sixteen field trials of which eleven were inter- and intra-varietal trials, two fertilizer trials and three cultural method trials.

In 1955, indicator trials, designed to show the response of the experimental field soils to ammonium sulphate and superphosphate, alone and in combination, over a wide range of rates of application, showed that the greater response was to ammonium sulphate. These trials have been continued.

Nigeria is unique amongst the West African territories in that most varieties of *Oryza sativa* have been introduced during the last fifty years. There are only a few varieties of *O. sativa* in the country whose origin and date of introduction are unknown and these are all upland types. However, most rices have been introduced by individual members of the Department of Agriculture or the Administration with the result that in most areas easily recognisable mixtures of successively introduced varieties are grown. Considerable improvement in quality could be obtained by reducing the number of varieties grown (which does not exceed ten) and distributing pure seed of those retained. This would ensure higher milling quality, even with the primitive processing now carried out in Nigeria.

It should be noted that the Eastern Region, where only one variety of rice was introduced by the Agricultural Department (in 1944), is now recognised by Nigerian consumers as the source of high-quality rice. In the Northern Region, where over two-thirds of Nigeria's rice is produced, the problem of mixture of varieties is greatest and is complicated by the presence of many cultivated varieties of the indigenous *O. glaberrima* with its red grain.

It was therefore decided to start two sets of variety trials lasting three years. The first set of four inter-varietal trials includes all the varieties now grown and varieties of similar life period but of reputedly improved yielding quality, introduced from abroad through the West African Rice Research Station, Sierra Leone. The second set of seven intra-varietal trials included W.A.R.R.S. selections of some of these varieties which were expected to show better characteristics than the parent stocks. The first set of trials is to be replicated in the Regional rice-growing areas in 1957.

It is relevant to note that one of the objectives of the plant breeding programme is to confine varieties within ecological zones to one grain type to improve milling quality. A producer-buyer-consumer survey is being planned to determine the major grain type preferences. With the principle of standardisation in mind a modified version of a four-year, four-stage rice multiplication scheme has been drawn up for further consideration. The scheme envisages three Regional seed multiplication centres producing seed rice for 150,000 acres annually.

Two hundred and forty-seven varieties were planted for observation. Of these thirty were new introductions and included thirteen medium- and deep-water tolerant varieties from abroad, and three upland varieties and fourteen medium- and deep-swamp varieties from within Nigeria. Particular attention was paid to varieties exhibiting the following characters :—

(*a*) resistance to flooding, submergence and drought, combined with non-shattering and erect habit,

(*b*) high yielding capacity on low fertility soils,

(*c*) resistance to lodging on highly fertile soils,

(*d*) adaptation to upland conditions,

(*e*) high yield combined with short duration,

(*f*) suitability for mechanised cultivation,

(*g*) resistance to Brown Spot (*Cochliobolus miyabeanus*) and Blast (*Pricularia oryzae*).

Most of the rice-growing areas of Nigeria can be classified into five ecological zones and possession of at least two of the characters mentioned above is particularly desirable in any variety intended for introduction to one of those zones. The five zones are :—

(*a*) Riveraine areas subject to rapidly rising deep floods,

(*b*) Riveraine areas subject to slowly rising deep floods,

(*c*) Riveraine areas subject to floods not exceeding 4 feet in depth,

(*d*) Swamp forest (fresh water),

(*e*) Mangrove swamp (fresh water).

In 1956 the varietal collection was transplanted after six weeks, whereas the previous two years it had been direct-seeded. The longer duration varieties were found to have shorter life periods in 1956 probably because they were the ones most severely affected by the flooding in 1955. In other varieties transplanting in 1956 generally lengthened the life period by three weeks. All other characteristics remained stable.

Some twenty-six new varieties, of which eight are upland types, were introduced from abroad for the 1957 season for trial in the Western Region. Eleven are deep-water floating varieties for trial in zone A areas of the Northern Region, and six are early maturing, shallow swamp types introduced at the request of the Eastern Region.

The 1954-1955 F.R.R.S. whole plant re-selections from established varieties were reduced, at the end of the season, from 187 to 42 stocks for further trial.

The sixteen F_5 and F_6 stocks of re-selections of five varieties imported from the West African Rice Research Station in 1955 were raised in observation plots for the second successive year.

Twenty-five varieties included in six varietal trials were multiplied to provide seed for 1957 trials at the Federal Rice Research Station and in the Regions. Some yields were low indicating soil variability but in several cases the results reflect those of the varietal trials.

Intra-varietal yield trials of shallow swamp rices included a comparison of selections of Demerara (Guiana) Creole, when the superiority of D 85/42, D 54/42 and D 99 over D 110 was demonstrated. Re-selections of GEB 24 proved GEB 24/37 to be the most satisfactory with regard to uniformity of character and flowering. No significant differences were detected in six strains of BG 79, the predominant shallow swamp rice in the Northern and Eastern Regions. The marked uniformity of all selections was noted.

A trial of five selections of Ngasein demonstrated the superiority of Ngasein 57 over 23 and 39. Ngasein 57 is found in many of the deeper flooding swamps in the Middle Belt rice-growing areas under a host of names indicating its assimilation into the traditions of the people. It is mostly consumed locally but when large amounts appear on the market it does not fetch as high a price as BG 79 because of its poor cooking qualities.

Inter-varietal trials designed to compare varieties of similar life period and ecological adaptation were also conducted.

Interim conclusions from the 1956 series of four inter-varietal trials are that the number of varieties in cultivation can be reduced to five for the main cropping areas. Four of these would be new introductions to Nigeria and would need to be proved acceptable on the basis of palatability. The recommended five are :—

(1) Indo China 53 (C type grain) for those areas where slowly arising flood waters not exceeding 5 feet in depth remain for longer than one month and soils are of varying fertility.

(2) Kav. 12 (small B type grain) for those areas where slowly rising flood waters not exceeding 4 feet in depth remain for more than 3 weeks and soils are of varying fertility.

(3) Bolo 108 (B type grain) for areas where water depths not exceeding 3 feet remain for longer than 3 weeks and soils are of varying fertility.

(4) Mas (B type grain) for areas where water depths do not exceed 2 feet and a 5½-6 month growing period is acceptable.

(5) D 114 (B type grain) for areas where water depths do not exceed 2 feet and growing period beyond 5 months not acceptable (the position now occupied by BG 79).

Fertilizer Trials.—Only one site at the Edozhigi Scheme could be obtained in 1956 for trials of rates of application of ammonium sulphate and superphosphate over a series of recognisable, physically different soils.

EA 12 (56).—This trial was designed to demonstrate yield responses to a wide range of combinations of nitrogen and phosphate. It was sited on Badeggi Series clay at Edozhigi where falling yields on Agricultural Department plots had been noticed for some years. The trial (with variety BG 79) failed to reveal any significant response to phosphate. Significant responses (P=0.1%) were obtained from the application of ammonium sulphate but 4 cwt/acre was not significantly better than 2 cwt/acre. The interaction figures were not significant though there were indications that the effects of high rates of application of nitrogen were reduced in the presence of phosphate. The conclusion reached was that there was a real deficiency either of nitrogen or of the common sulphate radical. The trial will be repeated.

EA 1 (55) *R* 56.—This was a second-year repetition, on the same site, of a trial designed to ascertain the optimum rates of application of nitrogenous and phosphatic fertilizers required to increase the yield of rice. The trial was designed by the Senior Chemist, Northern Regional Research Station.

The results of 1955 and 1956 indicate that, at Badeggi, the greatest responses are obtained to applications of ammonium sulphate and that, if nitrogen is supplied, phosphate applications are likely to have a much reduced effect. The 1955 and 1956 figures indicate no significant interaction between nitrogen and phosphate. It will be noticed that the no-manure yields have increased in 1956. This was to be expected since the land was newly cultivated in 1955 and bacterial competition for the available nutrients no doubt existed.

TABLE 8.—RICE FERTILIZER TRIAL EA 1 (55) R56—YIELDS IN CWT./ACRE

Main effects		1956	1955
Ammonium sulphate	(N)	—	—
Nil	(N0)	20.04	11.99
½ cwt./acre	(N1)	22.91	18.46
1 cwt./acre	(N2)	26.75	21.46
1½ cwt./acre	(N3)	30.33	22.93
Superphosphate	(P)		
Nil	(P0)	22.92	16.24
½ cwt./acre	(P1)	23.76	18.74
1 cwt./acre	(P)	25.93	19.58
1½ cwt./acre	(P3)	27.40	20.29
S.E.	=±	0.82	±0.40
5 per cent significant Diff.			1.15
1 per cent Significant Diff.			1.54
0.1 per cent Significant Diff.			2.02

Main Effects (1956)		1956		1955
Linear effect	N^1	7.05	±	0.58
Quadratic effect	N^2	0.36		0.58
Cubic effect	N^3	3.23		0.58
Linear effect	P^1	3.32		0.58
Quadratic effect	P^2	0.31		0.58
Cubic effect	P^3	1.15		0.58

Results

Nitrogen.—The linear and cubic effect of N were highly significant (P=0.001). The quadratic effect was not.

Phosphate.—The linear effect only was significant (P=0.001).

Interactions.—Owing to the system of confounding it was not possible to present a two-way Table in the usual way. None of the components of interaction were significant.

Badeggi Series sandy clay, yields normal, rice variety BG 79.

Regional Fertilizer Trials.—Results of some trials and observations carried out by the Northern Region Department of Agriculture have been received. Since these will be reviewed in the Regional Annual Report only general conclusions will be reported here. All were carried out on alluvial soils without, with two exceptions, any water control. At Ibaji and Bassangi, Kabba Province, and at Utur-Mbagen on the flood plain of the Katsina Ala River, Benue Province, responses to ammonium sulphate were observed, and similar responses by three upland rice varieties were observed at the Lowlands Experimental Farm, Plateau Province.

There also, and at Maigana, Zaria Province, significant responses to combinations of nitrogenous and phosphate fertilizers were noted in rice growing on flooded land. At Samaru, with controlled irrigation, responses to phosphate only were noticed. At Kwarri, Sokoto Province, with controlled irrigation, responses to slight dressings of nitrogen and phosphate were observed, but muriate of potash tended only to reduce the yield response due to nitrogen.

Thus, although there is a slight suggestion that responses to phosphate become more marked further north, no definite pattern of response can be established without many more experiments and correlation with soil types. Information on the soil type was scanty in all experimental reports received.

Cultural Method Trial F.R.R.S. 1956.—Of the three originally proposed it proved impossible to establish EA15 (56) owing to the difficulty of obtaining even germination of seed sown on the flat. Of the remaining experiments one achieved significance, but soil variability led to a high coefficient of variation in the other.

*EA*13 (56).—This trial was designed to determine the optimum combination of spacing and plant population per stand for rice transplanted on the flat, and the result in 1956 was more clearly defined than that of 1955. Yields indicated that, within the range employed, variation in the number of plants per stand had no significant effect. There was, however, a marked difference in yield between the two spacings (9×9 inches and 15×15 inches), the yield being higher at the closer spacing. The coefficient of variation was higher than in 1955 when no difference in yield resulted from spacings of 6×6 inches and 12×12 inches. Yields were lower than in 1955 and the general conclusion drawn is that, on the poorer soils, a falling off in yield is to be expected when spacing exceeds 12 inches. The interactions are positive at the closer spacings. The experiment is to be again repeated in 1957 on better soil.

*EA*14 (56).—This trial was a re-designed version of EA6 (55) intended to demonstrate possible yield differences arising from two local methods of cultivation. It was necessary, of course, to resolve farmers' practice into exact quantities and this is open to criticism. The two methods were resolved as follows :—

Edozhigi Method.—Transplanting six-weeks-old seedlings at 12×12 inches spacing on the flat, 4 plants/stand, water depth 3 inch.

Badeggi Method.—Direct seeding on to ridges 3 feet apart, in two rows 12 inches apart, 12-inch spacing, 15 seeds/hole.

The details of both methods were based on a local survey. The seed rate of the Badeggi method gives about 24,000 plants per acre compared with 10,000 by the Edozhigi method. As in 1955, the results were not statistically significant. The trial will be modified in 1957 to give the same plant population per acre in both treatments.

Regional Liaison.—Several sets of seed of selected varieties were sent out for regional observation apart from the trial replications already reviewed. Inadequate knowledge of some local conditions gave rise to severe damage or loss of material and little conclusive information was obtained.

Seed and instructions for laying down 33 replicate trials or observations of the current four F.R.R.S. inter-varietal trials have been sent to the Regions for 1957. In addition four replicates of the two new deep-water inter-varietal trials have been distributed in the Northern Region and three replicates of one intra-varietal trial to the Western Region for 1957.

PLANT PATHOLOGY

STAFF

S. R. Chant .. .. *Plant Pathologist*
J. A. Marden .. .. *Technical Officer*

The major project investigated during the period under review was cassava mosaic disease. Other investigations included a wilt of cocoa seedlings, a suspected virus disease of yams and studies of the causal agent of citrus gummosis.

CASSAVA MOSAIC

Preliminary investigations on the effect of the virus on yield, growth rate, carbohydrate : nitrogen ratio of leaves and respiration rates of infected and healthy leaves have been carried out jointly by the Federal Botanist and the Federal Plant Pathologist. The results have been submitted for publication in "Tropical Agriculture".

The techniques for handling white-flies have been improved. The insects can be anaesthetised with carbon dioxide for approximately one minute without deleterious effects. In this state they can be introduced to feeding cages on cassava seedlings before they become active again. Two types of feeding cage have been employed. One type is a small cylindrical micro-cage made of cellulose acetate covered at one end with fine gauze and at the other with a movable Perspex lid, and the other takes the form of glass tubes 1 inch in diameter and 3 inches in length.

The micro-cage is fastened on to the lower surface of a young leaf by rubber bands. The tube is placed over the stem apex of the plant, the base being packed round with cotton wool and the top being covered with muslin after the white-flies have been introduced. As *Bemisia* are attracted to light the tubes are covered with black paper to induce them to settle on the leaves.

By using the method of feeding vectors on the stem apices it has been shown that a single white-fly can transmit the virus. Experiments were carried out to determine the percentage of infection of cassava seedlings using groups of 1, 5, 10, 50 and 100 infective *Bemisia*. The results (the aggregate of 3 experiments carried out over 6 months) are shown in Table 9.

TABLE 9.—EFFECT OF NUMBER OF INFECTIVE WHITE-FLIES ON THE TRANSMISSION OF CASSAVA MOSAIC

Flies	*Plants tested*	*Plants showing Symptoms after* 14 *days*
1	19	2
5	24	8
10	18	8
50	15	7
100	15	8

White-flies after feeding on the infected plants were starved for various periods and introduced on to healthy plants. White-flies starved for 18 hours did not survive but those starved for as long as 15 hours were still capable of transmitting the virus.

Additional experiments were carried out entailing the transference of infective white-flies to a succession of healthy plants every 24 hours. The method of feeding the vectors on the stem apices was employed and it was observed that at the end of three transfers the white-flies were still capable of infecting healthy seedlings.

The fact that seedlings were still being infected 72 hours after the white-flies had last fed on an infected plant establishes that the virus is persistent and it is probable that the *Bemisia* remains infective throughout its adult life.

From experiments conducted over the past nine months it has been established that *Bemisia* can transmit mosaic to healthy seedlings after feeding on them for fifteen minutes.

The white-flies were fed on the young leaves of infected cassava plants for 24 hours before being transferred to healthy seedlings. The white-flies were enclosed in glass tubes round the stem apices, as previously described, and were left to feed for periods of time from 5 minutes to 12 hours. No transmissions were recorded in any of the experiments where the *Bemisia* had been fed for periods of 5 or 10 minutes but over 20 per cent of healthy seedlings became infected when the vector was allowed to feed for 15 minutes.

Further attempts to transmit cassava mosaic virus mechanically have failed, possibly owing to the presence of an inhibitor in the cassava sap. The infectivity of tobacco mosaic virus mixed with cassava leaf sap extracts (in various dilutions) on *Nicotiana glutinosa* has been investigated experimentally.

The results show that there is no reduction in the number of local lesions produced on the *N. glutinosa* leaves even when tobacco mosaic virus is mixed with undiluted cassava sap extracts.

Experiments with heat therapy in an incubation chamber have given promising results with infected cassava cuttings grown at temperatures of 35°C for 3 and 4-week periods. It is thought that the virus is being completely inhibited in the green stems but that it is still able to survive in the thick woody cutting. A technique has now been developed for rooting green stems after 14 days' growth. These are now being subjected to heat treatments culminating in a 4-week treatment at 37.5°C.

COCOA SEEDLING WILT

The results of two years' investigations on this disease have been published in a memorandum which has been circulated to all Regional Departments of Agriculture and to the West African Cocoa Research Institute.

The wilt disease of *Theobroma cacao* L. seedlings is caused by what is thought to be *Phytophthora palmivora* Butl. This is the first record of the pathogen causing a seedling disease in Nigeria although a similar disease is known in Costa Rica and Surinam. Under Nigerian conditions seedlings up to 6 weeks old are highly susceptible and are usually killed as a result of infection.

Spread is believed to be due to air-borne sporangia and is random at least in the early stages of infection. Incidence of wilt is greater under conditions of heavy shade and high relative humidity. Factors such as soil sterilisation, seed treatment and source of seeds (*i.e.*, from healthy or black-pods) have no effect on disease incidence although there is a greater incidence of wilt in seedlings grown under conditions of high rainfall and heavy watering in a clay and compost soil than in seedlings grown in a sandy soil.

The disease is controlled by spraying with a copper fungicide "Perenox", and it has been shown that a 0.3 per cent or 0.5 per cent spray applied at 3 or 6-day intervals from one week after germination till the seedlings are six weeks old gives 95 per cent control of the disease.

SUSPECTED VIRUS DISEASE OF YAMS

Tubers from yams displaying symptoms of this disease were collected in November and December 1956 and are now being grown under observation.

CITRUS GUMMOSIS

In July and August 1956 a species of *Phytophthora* was consistently isolated from Sierra Leone rough lemon stocks and later from stocks of Rangpur lime and sweet orange (Agege No. 1) displaying symptoms of gummosis disease at the base of the trunk. This isolate has not so far been identified, as the Commonwealth Mycological Institute are of the opinion that owing to peculiarities in the structure of the sporangial wall of the isolate it must be regarded as either a new species or a new variety of *P. parasitica.*

The technique used in the isolation of the Phytophthora was one suggested by Dr. J. C. F. Hopkins and entails the washing of portions of bark in tap water for a period of 24 hours and then planting them in egg plant fruits, *Solanum melongena* L. The fungus invades the tissue of these fruits and 72 hours after inoculation it is possible to isolate it from the sub-epidermal tissue.

Attempts to isolate Phytophthora from the original lesions on rough lemon stocks in the dry season were unsuccessful and it is considered that the fungus dies out in the cambium with the onset of dry conditions.

Preliminary investigations were carried out to determine the nature of the susceptibility of rough lemon and the resistance of sour oranges to gummosis. Bark extracts from Sierra Leone rough lemon and sour orange were prepared by various methods and sterilised by passing through a bacterial filter before being incorporated in potato dextrose agar in petri dishes.

No inhibition of the growth of *Phytophthora* nor in the production of sporangia was observed in the culture media. Although sour orange bark was found to be slightly more acid (pH5.4-5.8) than rough lemon bark (pH 5.8-6.2) this could not be regarded as a possible cause of resistance in the former. It was found in tests on the growth of the fungus in potato dextrose agar acidified at the levels 4.0, 4.4, 4.8, 5.1, 5.4, 5.8 and 6.2 that although no growth was recorded in media with a pH of 4.8 or less there were virtually no differences in diameter of colonies grown in media of pH 5.4, 5.8 and 6.2.

When the phenols from sour orange and rough lemon were extracted for 24 hours with ethyl acetate and then taken up with distilled water, sterilised and incorporated in agar plates, it was found that they completely inhibited the growth of *Phytophthora*.

The reaction to the fungus of the inner surface of excised portions of bark was studied. Although the hyphal spread on both sour orange and rough lemon bark was comparable, a darker brown necrosis was observed in the latter.

PINEAPPLE FRUITLET BROWN ROT DISEASE

(J. M. Waterston)

The large-scale cultivation of smooth cayenne pineapples is a recent development in the Western Region where the crop has been introduced as a measure to assist in the rehabilitation of the area devastated by swollen shoot disease of cocoa. As was to be expected with a new crop, various agronomic problems arose, one of the most important being the incidence of fruit rots. Damage amounted to 45 per cent or more of the fruit harvested during the onset of the dry season. A considerable proportion of this damage could be attributed to over-ripe fruit occasioned by the difficulty of gauging maturity based on "green-ripe" symptoms. A visiting pineapple expert Dr W. Carter from Hawaii expressed the opinion that this problem would prove mainly non-parasitic and would appear in proper perspective when the agronomical details of pineapple culture in Nigeria had been worked out.

The contribution of "Fruitlet Brown Rot" disease to fruit wastage was slight and is shown in Table 10. A total of 9,391 fruits were examined at harvesting over a 28 months period, when the disease was shown to have an average monthly incidence of 3.5 per cent (range 0-10. 8 per cent). There was no evidence that the production of fruit affected with fruitlet brown rot was confined to particular stands. When successive fruits produced per stand were analysed, the order of production of soud or defective fruit was found to follow closely a pattern of random distribution according to the binomial theorem, as is shown in Table 11. The causal agent of fruitlet brown rot remains undetermined.

Inspection of fruit during the cropping cycle at Ibadan revealed that only 50 per cent of the smooth cayenne pineapple crop was harvested at 23-24 months from planting, in contrast to Hawaii where the cropping cycle yields 75 per cent of the crop during this period. Dr Carter has suggested that some of the probable limiting factors are unsuitable planting material and inadequate levels of fertilizer application and the problem calls for further study.

Table 10.—Incidence of Pineapple Fruitlet Brown Rot in relation to Progress of Harvesting of Fruit of the Smooth Cayenne Variety at Moor Plantation, Ibadan

Date	*Months from planting*	*Fruitlet Brown Rot %*	*Fruit harvested expressed as a % of grand total*	*Fruit harvested expressed as % of cumulative total*
1952				
July	0.0	0.0	0.0	0.0
1954				—
February	19	4.4	16.8	—
March	20	3.8	20.8	—
April	21	3.7	4.8	—
May	22	2.7	6.0	—

TABLE 10.—INCIDENCE OF PINEAPPLE FRUITLET BROWN ROT IN RELATION TO PROGRESS OF HARVESTING OF FRUIT OF THE SMOOTH CAYENNE VARIETY AT MOOR PLANTATION, IBADAN—*continued*

Date	*Months from planting*	*Fruitlet Brown Rot %*	*Fruit harvested expressed as a % of grand total*	*Fruit harvested expressed as % of cumulative total*
1954				
June	23	3.8	1.9	—
July	24	—	—	50.3
August	25	—	—	—
September	26	0.0	0.2	—
October	27	—	—	—
November	28	—	—	—
December	29	10.8	0.8	—
1955				—
January	30	2.3	7.0	—
February	31	2.6	7.1	—
March	32	9.3	1.5	—
April	33	4.3	3.0	—
May	34	3.3	1.0	—
June	35	0.0	0.7	—
July	36	1.8	4.7	76.3
August	37	0.0	1.3	—
September	38	3.6	0.6	—
October	39	0.0	0.2	—
November	40	8.4	1.3	—
December	41	6.0	1.1	—
1956				—
January	42	6.3	1.9	—
February	43	1.0	9.1	—
March	44	6.1	2.8	—
April	45	3.3	3.8	—
May	46	1.3	1.6	100.0

TABLE 11.—INCIDENCE OF FRUITLET BROWN ROT DISEASE IN SUCCESSIVE CROPS OF SMOOTH CAYENNE PINEAPPLES HARVESTED FROM INDIVIDUAL STANDS WHICH PRODUCED (*i*) MAIN CROP ONLY (*ii*) MAIN CROP PLUS ONE RATOON AND (*iii*) MAIN CROP PLUS TWO RATOONS. A TOTAL OF 9,391 PINEAPPLES WERE HARVESTED OF WHICH 327 WERE DEFECTIVE

Fruit from Stands producing Main Crop only and no Ratoons	*Percentage observed*	*Percentage expected*
Defective	3.4	3.482
Sound	96.6	96.518
Fruit from Stands producing Main Crop plus one Ratoon		
Both Defective	0.2	0.121
One Sound and one Defective	6.8	6.702
Both Sound	93.0	93.157

TABLE 11—*continued*

Fruit from Stands producing Main Crop plus two Ratoons			*Percentage observed*		*Percentage expected*	
All Three Defective			0.0		0.004	
Two Defective with One Sound						
Sound	Def.	Def.	0.3		0.117	
Def.	Sound	Def.	0.0	0.5	0.117	0.351
Def.	Def.	Sound	0.2		0.117	
One Defective with Two Sound						
Sound	Sound	Def.	2.7		3.244	
Sound	Def.	Sound	2.6	9.1	3.244	9.688
Def.	Sound	Sound	3.8		3.244	
All Three Sound			90.4		89.913	

PLANT QUARANTINE

Mr J. A. Marden took up his duties as Plant Quarantine Officer in February 1957. He has catalogued all Plant Quarantine Certificates and Import Permits issued since January 1955 and has drawn up a comparative Table to show the differences between the Plant Quarantine Legislation of Nigeria and that of the other African territories with respect to the main plants of economic importance. Sixty-six Phytosanitary Certificates and 67 Import Permits were issued during the year.

Certain alterations were made in the procedure for the importation from Ghana of rooted cuttings of Amazen cocoa for the Western Region Department of Agriculture. In 1955 and the first half of 1956 these cuttings on arrival were planted and kept in the Federal Quarantine House till they had flushed and had been inspected by the Quarantine Officer. However, owing to high temperature and low relative humidity in the greenhouse there were high losses of cuttings (up to 60 per cent).

A new procedure was adopted in July 1956 when it was decided that the cuttings should be potted and kept under observation in polythene-covered bins in the Western Region cocoa propagator immediately on arrival.

In December 1956 a cutting of one variety (T60/888) was found in the propagator to be displaying leaf symptoms similar to those of cocoa swollen shoot virus. A subsequent communication from the West African Cocoa Research Institute, Ghana, in February confirmed that one of the trees (T60/887) at Tafo from which cuttings had been sent to Ibadan had been found displaying symptoms of swollen shoot.

The Western Region Department of Agriculture and W.A.C.R.I. co-operated with the Federal Department of Agriculture in destroying all surviving cuttings of T60/888 of consignment No. 11 which had been planted in the clonal nursery as these cuttings were derived from a tree at Tafo in immediate contact with T60/887. All cuttings of T60/887 and T60/888 in the propagator were removed to the Federal Quarantine House and the W.A.C.R.I. insectaries for budding tests. So far all tests have been negative but as a result of this interception the Federal Department of Agricultural Research has erected a special screened quarantine cocoa propagator in the Federal Quarantine nursery for future importations of rooted cuttings.

ENTOMOLOGY

STAFF

G. S. Cotterell	*Senior Entomologist*
J. L. Gregory	*Entomologist*
K. M. Harris	*Entomologist*
Dr V. F. Eastop	*Visiting Entomologist*
F. O. Iwenjora	*Laboratory Technologist*

DESERT LOCUST

There was a considerable amount of locust activity in Nigeria during the year with 65 swarms reported in the Northern Region from October to March. An unusual feature was the over-wintering of swarms in this region. In a normal year, swarms fly to North Africa for breeding in October or November and locust are not generally seen in Nigeria until the southward migration in the following July or August. The year under review, however, was exceptional in that swarms were found present in Nigeria flying with no constant directional movement during the whole of the dry season. At the end of the year there were no signs of approaching sexual maturity and no immediate danger of egg laying. As only adult swarms were present, no control measures were attempted.

THE BIOLOGY AND CONTROL OF YAM BEETLES (*Heteroligus* sp.)

(J. L. Gregory)

Experiments were conducted in both the Eastern and Western Regions to test the effect of various insecticidal dusts applied to seed yams at the time of planting both on the weight of yams harvested and on the control of the damage caused by the yam beetle, *Heteroligus meles* Billb.

In previous years, a 0.45 per cent gamma BHC dust applied to yam setts before planting increased the yield of yams in plots where the incidence of yam beetle attack amounted to 40 per cent or more. Further information was required on control measures against yam beetle in other parts of Nigeria. Consequently, experiments were laid down to compare BHC dusts (0.45 per cent, 2.6 per cent (Lindane) and 2.6 per cent (Crude)) with the following insecticidal dusts : 50 per cent Chlordane wettable powder, 10 per cent DDT dust and 25 per cent Heptachlor wettable powder.

Eight trials were carried out, two in the Northern, two in the Western and four in the Eastern Regions. All insecticides were applied to the yam setts before planting and the main effects observed were on yield and percentage of yams attacked by beetle. One trial at Mokwa was subsequently abandoned through poor germination of the planting material.

Effect on Yields.—Plots treated with 0.45 per cent gamma BHC dust gave an average increase in yield of 32 per cent (range 19-129 per cent) compared with untreated plots in experiments in the Eastern and Western Regions. However, an unexpected reduction in yield, which requires further investigation, was obtained at Shendam in Plateau Province on plots treated with 0.45 per cent gamma BHC dust. A 2.6 per cent gamma BHC dust based upon crude BHC was used in two experiments and produced increases in weight of 14 and 20 per cent. In both experiments, the use of this insecticide resulted in greater yield than that of any other insecticide. A 50 per cent Chlordane wettable powder increased yields by an average of 33 per cent (range 13-70 per cent) in five trials. In one further trial however the insecticide was apparently responsible for poor germination which lowered yields.

Reduction of Damage.—Plots treated with 0.45 per cent gamma BHC dust reduced the percentage of yam tubers attacked by beetles by 22 per cent (range 4-48 per cent). The control obtained was rather less effective than in previous years, but the amount of dust used was less.

In two experiments, a 2.6 per cent gamma BHC dust based on crude BHC reduced damage by 31 per cent and 13 per cent. This dust gave better control than any other with which it was compared.

In seven experiments, 50 per cent Chlordane wettable powder reduced the percentage of yams attacked by 32 per cent (range 0-50 per cent) and in four experiments, 2.6 per cent gamma BHC (Lindane) reduced damage by 22 per cent (range 17-30 per cent).

Effect on Palatability.—It is important to ensure that the insecticidal treatments should impart no unpleasant taste to the yams. The flavour of yams obtained from treated setts has been tested in previous years and no unpleasant taste has been noticed. However, as flavour is so important, a further test was applied to confirm previous experiments.

Yams were taken from each of the plots treated with BHC and from the untreated plots in the experiment at Sobe in Ondo Province. The flavour of the top of one yam was compared with that of the bottom of another yam of a different treatment after both had been boiled separately with salt. Tasting was done by Agricultural Assistants from the School of the Western Region Department of Agriculture who stated whether they preferred the flavour of the bottom or top halves or whether both had an equally good taste. The test revealed that there were no significant differences in flavour.

WHITE-FLY VECTORS OF VIRUS DISEASES

(G. S. Cotterell)

There is doubt regarding the validity of the various species of *Bemisia* which have been described in the literature. Present investigations are directed to elucidating whether those in West Africa can all be referred to *Bemisia tabaci*, and research on the vectors of virus diseases of tobacco, cotton, and cassava are at present being directed towards this end.

Investigations were undertaken to define the host relationships of the common strains of *Bemisia* at Ibadan by means of transference experiments, some of which were not completed by the end of the year.

In one experiment, cassava leaves supporting about 50 pupae of *Bemisia* sp. were placed in small cages each containing one seedling of either cassava, cotton, sweet-potato, tobacco, tomato or *Euphorbia heterophylla*. More pupae were collected daily and introduced into the cage. After one month over 50 pupae were found on the cassava, cotton, tomato and Euphorbia plants but none on the sweet potato or tobacco.

In another experiment, pupae collected from cotton and tomato plants in the previous experiment were transferred to caged cassava plants. In two weeks, 40 pupae were present on the cassava plants infested with pupae from cotton and 50 on plants infested with pupae from tomato.

It was thus shown that the white-fly from cassava can breed also on cotton, tomato and Euphorbia. Further investigations on host plants of *Bemisia* sp. will be carried out.

STUDIES OF THE CAPSID PESTS OF COCOA

(J. L. Gregory)

Large-Scale Spraying Trials.—The trials carried out in the previous year showed that applications of spray formulations based on gamma BHC at 4 oz. and 6 oz. gamma BHC in 5 gallons of water per acre at monthly intervals from August to February prevented capsids from damaging mature cocoa trees.

This year, only five observation plots of approximately one acre each were sprayed six times with 6 oz. of gamma BHC in 5 gallons of water by means of power-operated low-volume shoulder-mounted sprayers at intervals of five weeks commencing in late August. The experiment was continued to determine the rate of recovery of the canopy from capsid damage and the increase in yield following this recovery.

Considerable improvement of tree condition was observed during the year. About 4 per cent of the trees died but the remainder regenerated well. An increase in yield twice as great as that of the previous year followed the improvement in canopy condition.

Large-scale Dusting Trial.—In the year 1955-56 dusting with 0.65 per cent gamma BHC effectively controlled capsids and prevented further capsid damage in 240 acres of mature cocoa.

During the present year only five blocks of approximately one acre each were dusted to determine the rate of recovery of the trees and the increases in yield obtained. Twenty pounds of 0.65 per cent gamma BHC dust was applied six times at five-weekly intervals from 30th August.

The trees were scored for canopy condition in early July 1956. Tree condition improved considerably but recovery was rather less than in the above trial.

As in the other experiments the improvement in tree condition was accompanied by an increase in yield, which was in this case 1.8 times greater than that of the first year.

Low-volume Spraying with Hand-operated Knapsack Spraying Machines.—In the previous year, hand-operated knapsack spraying machines gave good control of capsids on mature cocoa, when 6 oz. gamma BHC in 25 gallons of water was used per acre.

A further trial was started to determine whether 4 oz. gamma BHC in 8 gallons of water per acre applied by hand-operated knapsack sprayers would control capsids on mature cocoa trees. Two plots of about 3 acres each, separated by a belt of cocoa 45 yards wide, were chosen and one was sprayed with 4 oz. gamma BHC per acre on six occasions from early September to the end of March. In each plot 100 trees were selected. The number of capsids on the selected trees was counted weekly ; trees were harvested and ripe and black pods counted every three weeks. In order that the harvesting figures should not be affected by black pod disease, both plots were sprayed at 3-weekly intervals from early September to the end of March with 2 oz. Perenox in 3 gallons of water.

The population of capsids on the two plots was similar at the beginning of the experiment. After the first spraying the population fell in the treated plot and after the end of September did not again rise above 10 bugs per 100 trees. In the untreated plot the population rose sharply to a peak of 310 bugs per 100 trees in early December and was always considerably higher than that of the treated plot.

Thus 4 oz. gamma BHC in 8 gallons of water per acre applied every 5 weeks to mature cocoa gave a very good control of capsids.

The number of pods harvested was greater by 27 per cent on the treated plot. This could have been due to the better original tree condition of the treated trees. However, the number of pods on untreated and treated plots in the first three months was 856 and 1,001 respectively (an increase of 17 per cent) whereas after that period it was 1,134 and 1,521 (an increase of 34 per cent).

Aerosol Application.—This trial was designed to determine the effectiveness of a BHC aerosol on numbers of capsids on mature cocoa and on the damage that they caused. A plot of two acres near Alapako in Abeokuta Province which contained trees in varying canopy conditions was chosen for the trial. There was no untreated plot because an aerosol drifts considerably and this would seriously affect the results obtained from any adjacent untreated plot. The plot was first treated with aerosol made from a mixture of 1 part 20 per cent gamma BHC emulsion concentrate with 3 parts of diesel oil. From 3 to 4 pints of mixture were used for each application. The aerosol was first applied in early September and thereafter at 5-weekly intervals until mid-March—a total of 6 applications.

Counts of capsids were made weekly. At first 46 bugs per 100 trees, the population after fluctuations reached a peak of 70 bugs per 100 trees in early January. Later it fell steadily and remained below 10 bugs per 100 trees after the middle of February.

The control effected by this method of application was therefore not as good as that obtained by other methods.

Incorporation of BHC with Fungicidal Sprays.—This experiment was designed to determine how well a mixture of gamma BHC and Perenox applied against black-pod disease controlled capsids on mature cocoa.

Two contiguous plots of one acre each were chosen near Alapako in Abeokuta Province. Twenty-five trees in each of the three lowest categories of canopy condition recognised were selected.

The untreated plot was sprayed with 2 oz. Perenox and the treated plot was sprayed with 1 pint Gammalin 20 and 2 oz. Perenox, both in 3 gallons of water. In both plots the spray was applied to pods by means of a hand-operated knapsack sprayer on six occasions between early September and the end of March.

The number of bugs on the selected trees was counted once a week and both black and ripe pods were harvested every three weeks. At the beginning of the experiment the number of capsids per 100 trees on the BHC and Perenox treated plot was 19. It slowly fell after treatment and only twice rose above five after the beginning of October. The plot treated with Perenox alone originally had 51 bugs per 100 trees ; the population rose to 60 at the end of September, fell to about 15 from mid-October to mid-November and rose again to 45 in early December. Finally, it dropped below 10 bugs per 100 trees at the beginning of February and remained at this low level to the end of the year.

The plot treated with BHC and Perenox yielded more pods than the plot treated with Perenox alone, throughout the time that harvesting was done. In the first three months the number of pods in the treated plot was 65 per cent higher and in the second three months 82 per cent higher than that in the untreated plot. Control of capsids appeared therefore to cause some yield increase in the first year.

The treatment of BHC and Perenox as a target spray on pods alone reduced the capsid population during the period of spraying but the reductions were not as great as those effected by the standard practice of applying BHC to the trunk and canopy.

Comparison of Coppicing with Spraying.—The comparison of the economics of capsid control by spraying with that of coppicing mature trees was started in 1955 at Owena. As in the previous year, the uncoppiced plots were kept free from capsid attack by spraying with 6 oz gamma BHC in 5 gallons of water per acre every five weeks, commencing at the end of August and finishing towards the end of February—a total of six applications. The coppiced plots were protected by spraying with 1.25 per cent DDT every five weeks, commencing at the end of August.

Tree canopy condition was assessed in early July 1956 using a system of visual scoring.

Tree condition improved considerably after one year free from capsids but the average increase in score was less than that recorded in February 1956, showing that tree condition scores taken at different times of the year should not be compared.

This year as in the last, the average yield of the uncoppiced trees increased with increasing canopy score. The yield of pods per tree in the second year was three times greater than in the first year.

The regeneration of the coppiced plots has improved and is now proceeding well. A few flowers have appeared on the chupons and some pods may be expected in the coming season. A little capsid damage was observed before spraying began at the end of August but none after.

Until the coppiced plots begin to yield it will not be possible to determine the economice of the experiment. It seems certain, however, that it will be economic to coppice only ths trees with very poor canopies. Regeneration has proceeded very well in all sprayed plots and yields, even of trees with the lowest canopy score, have increased considerably. Coppiced trees may regenerate more rapidly than sprayed mature trees and so make up for the years in which they did not yield, but there is insufficient evidence yet to make recommendation for coppicing as a control of capsids.

CEREAL PESTS

(K. M. Harris)

Guinea-corn Observation Plots.—In a rotational planting experiment at Samaru, yields decreased with lateness of planting from 1,500 lb/acre when planted on 29th May to 450 lb/acre when planted on 24th July. All plantings were equally infested with borer, 95 per cent of all stems being bored. Sorghum midge damage was negligible and the reduction in yield must be attributed to lateness of planting.

Populations of stem-boring larvae observed on 1/20th acre at harvest were :—

	Larvae per acre
Sesamia sp.	1,657
Busseola sp.	156,998
Eldana sp.	592

The yield was 1,190 lb threshed grain per acre.

These figures are supported by observations on an adjacent area of 1½ acres of guinea-corn which, although having more than 90 per cent of its stems bored, produced a yield of threshed grain well in excess of 1,000 lb/acre—a good yield despite a severe stem borer attack.

A ½-acre block of Tall Kaura guinea-corn, also at Samaru, was divided into four equal areas and a classification made in each quarter of stems which were severely bored, slightly bored, and not bored. These stems were harvested separately and detailed data on stem widths at the base of the head, sorghum midge, covered smut and bird damage were obtained.

The main results are given in Table 12.

Table 12.—Summary of Observations made on Yield, Stem Diameter at Base of Head and Stem Borer Attack on Guinea-Corn at Samaru in 1956

	Heads Harvested	*Av. Wt. of Threshed Grain/Head (lb)*	*Av. Stem Diam. at Base of Head (cm.)*
Block I			
Stems Not Bored	390	0.055	0.816
Stems Slightly Bored	227	0.066	0.934
Stems Severely Bored	270	0.086	1.000
Block II			
Stems Not Bored	250	0.060	0.791
Stems Slightly Bored	190	0.078	0.887
Stems Severely Bored	360	0.100	1.020

TABLE 12.—SUMMARY OF OBSERVATIONS MADE ON YIELD, STEM DIAMETER AT BASE OF HEAD AND STEM BORER ATTACK ON GUINEA-CORN AT SAMARU IN 1956—*continued*

	Heads Harvested	*Av. Wt. of Threshed Grain;Head (lb)*	*Av. Stem Diam. at Base of Head (cm.)*
Block III			
Stems Not Bored	240	0.054	—
Stems Slightly Bored	190	0.089	—
Stems Severely Bored	280	0.092	—
Block IV			
Stems Not Bored	190	0.052	—
Stems Slightly Bored	330	0.082	—
Stems Severely Bored	250	0.109	—

Over-all per cent Stems bored=66
Stand density=6,300 stems per acre
Over-all yield=554 lb threshed grain per acre

The results indicated an apparent paradox of severely bored stems producing the highest yield. On interim observations a rough calculation based on an established correlation between stem diameter at the base of the head and final yield of threshed grain has shown that severely bored stems have produced about 200 lb/acre less threshed grain than uninfested stems would have produced. The data were submitted to Dr Yates at Rothamsted who was however unable to obtain statistical corroboration of this observation.

Half-acre adjacent plots of Farafara (*ex* Samaru) and a local Tall Kaura guinea-corn at Kafinsoli were sampled in the late growing season and gave the data shown in Table 13.

TABLE 13.—GRAIN LOSSES IN LATE PLANTED GUINEA-CORN

	Farafara	*Tall Kaura*
Sorghum Midge	2%	5%
Bird Damage	0.1%	28%
Covered Smut	1%	8%
Estimate of Factor for Expected Yield=Potential Yield—Losses	69	42
Actual Yield (threshed grain, lb/acre)	614	590

It was forecast from the sampling that Farafara would produce a higher yield than the Tall Kaura but it did not in fact show as big an increase as expected. It is possible that the Farafara suffered attack from birds after the time of sampling, in which case its yield would be reduced.

Over-all borer infestation was 15 per cent of all stems bored. *Busseola* was the dominant genus and there is little indication of a varietal difference in susceptibility.

A further observation plot was established at Kano where Tall Kaura (*ex*),Kano Farafara (*ex* Samaru) and Short Kaura (*ex* Samaru) were planted in adjacent one-third-acre plots. Detailed sampling was carried out during the growing season and at harvest and Table 14 shows the yields obtained.

TABLE 14.—RELATION BETWEEN VARIETY OF GUINEA-CORN AND EXTENT OF STEM-BORER DAMAGE

	No. of Stems	*Total Wt. on Head (lb)*	*Yield on Head (lb/acre)*
Tall Kaura			
Not bored	1,098	67.25	612
Slightly bored	1,724	202.00	1,170
Severely bored	507	82.75	1,630
Farafara			
Not bored	2,070	57.50	280
Slightly bored	1,144	34.75	300
Severely bored	141	5.75	410
Short Kaura			
Not bored	1,210	55.50	460
Slightly bored	1,323	63.75	480
Severely bored	105	6.75	640

The yields of Farafara and Short Kaura are very low as the growing season was not in their favour. Nevertheless the general association of borer attack with yield is adequately demonstrated.

Figures for final yields of threshed grain are not available and the dissection of sorghum midge samples has not been completed.

In the guinea-corn observation plot at Mokwa, there was a very marked difference in yield between the half-acre plots of Farafara (*ex* Samaru) and local Farafara, as shown in Table 15; this can be attributed to the fact that the Farafara *ex* Samaru was severely attacked by sorghum midge.

Unfortunately it was not possible to compare yields of threshed grain since the samples of local Farafara were erroneously threshed along with the settlers' crop.

TABLE 15.—EFFECT OF PEST DAMAGE ON GUINEA-CORN YIELDS AT MOKWA

	Farafara ex Samaru	*Local Farafara*
Per cent Stems Bored 1-10-56	52	55
Per cent Stems Bored at Harvest	58	58
Stand at Harvest	10,136 per acre	9,968 per acre
Yield on Head	492 lb/acre	1,674 lb/acre
Per cent Spikelets containing no Grain	65	26
Field Overseer's Visual Estimate of Loss of Grain due to Midge	75	25

The average yield in pounds per head in a sample of 500 heads was as follows :—

	Farafara ex Samaru	*Local Farafara*
Not Bored	26.08	81.85
Slightly Bored	23.61	82.07
Severely Bored	24.12	87.17

The usual association of highest yield with severest borer attack did not appear in Farafara *ex* Samaru but the effect was probably masked by the heavy sorghum midge attack. The reason for the heavier midge attack on Farafara *ex* Samaru is not clear.

The dominant borer throughout the experiment was *Eldana.* This is unusual and no explanation can be given.

Millet Observation Plots.—At Samaru 74 per cent of stems of late millet crop were found bored at harvest. *Coniesta* was the dominant genus, 707 larvae being recovered from 260 stems. Yield was negligible and the loss can be attributed to stem borer attack.

At Kano, 95 per cent of all stems in a third of an acre of millet planted on 3rd July were bored. *Coniesta* was almost entirely responsible for the damage and 714 *Coniesta* larvae were recovered from 181 stems bored. As a result of borer attack the yield was very low. Final figures for yield of threshed grain have not yet been received.

The stem-borer problem appears to be greater in the millets than in guinea-corn and will receive more attention in the coming season.

Maize Stem-borers.—An experiment designed to test the effect of various insecticides on maize at Ibadan produced no significant results owing to the small size of the plots and failure to record yields with sufficient accuracy. Other unknown factors also contributed.

The overall yield from the experiment was 719 lb. of unshelled grain per acre and untreated plots gave an average of 616 lb. unshelled grain per acre. The highest yield and best stem-borer control was produced by application of 5 per cent DDT dust at 16 and 30 days after planting and, although these results are not significant, it is interesting to find that, of 50 different treatments, the one which shows to best advantage is already widely used in stem-borer control elsewhere in Africa.

Plots treated one week after planting gave 38 per cent more yield than plots treated five weeks after planting. This indicates that the practice previously adopted in these experiments, of applying insecticide when maize plants are at knee height (one month after planting), is not as efficient as earlier applications.

Field Studies on Busseola.—The following is a summary of some 200 individual breeding records of *Busseola fusca* :—

(*i*) *Carry-over generation.* (*Dry season : November-May*)

Larva : Longest observed duration : 186 days (November-April) None of the larvae collected between November 1955 and March 1956 pupated before April 1956. They remained in a non-feeding, resting stage throughout the dry season.

Pupa : Average duration : male and female, 14 days

(*ii*) *Wet season generations* (*June-October*)

Larva : Longest observed duration : 31 days
Pupa : Average duration : male, 12 ; female, 11 days
Adult : Average duration : male 7 ; female, 5 days
Egg : Average duration : male, 7 ; female, 5 days (few observations)
Estimated length of life cycle : 55+ days
Length of cycle derived from field observations as the time between peak pupation of successive generations : 61 days.

Field observations of *Busseola* on guinea-corn at Samaru during the period November 1955 to April 1957 indicate the following seasonal cycle :—

In October and November, at the onset of the dry season, *Busseola* larvae which were present in the stems remaining after harvest of the season's guinea-corn, maize and millet crops entered a resting stage which lasted until the rains began in April. During this period no pupae were formed and little feeding occurred.

In mid-April, after the first rains, these larvae pupated and, after about a fortnight, adult moths emerged. This first adult generation of the now growing season appeared before the main guinea-corn crop had been planted and oviposition was therefore confined to volunteer plants growing from the stubbles of the previous year's crops and the current early millet crop.

The second generation of adult *Busseola* appeared some 8 to 9 weeks later and oviposited on the main guinea-corn crop during the first week of August when the plants were about two months old.

A partial third generation of larvae appeared on the main crop in October and entered the resting stage along with the second generation larvae.

These observations were made at Samaru and because of the abnormal weather experienced in 1956 may not be applicable generally.

A large amount of information has been collected on stem borers other than *Busseola fusca* but, owing to taxonomic complications, it is not at present possible to report this work in the same detail as that of *Busseola fusca*.

The *Busseola* population which remains static in crop residues throughout the dry season appears to be particularly susceptible to control. The relative importance of different types of crop residue in carrying the borer from one season to the next has therefore been investigated.

(*i*) *Guinea-corn*

During the dry season the highest populations of *Busseola* are found in the pyramidal stacks of stems which the farmers make shortly after harvest.

Sesamia does not carry over in the resting stage but continues to breed and high populations are present on guinea-corn tillers growing in the dry season. Although the *Sesamia* population of 197 larvae per 100 tillers is much higher than any recorded dry-season population of *Busseola*, *Sesamia* is at a lower over-all level during the dry Season since tillers are eaten by goats and are therefore not very abundant, whereas the pyramidal stacks of stems are of widespread occurrence.

An experiment was carried out to compare the effect on the borer population of stacking the stems as opposed to leaving them lying in the field. The results given in Figure 1 show that the difference in the level of borer population between stems which had been stacked and those left lying in the furrows is appreciable and may prove of great importance in designing cultural control methods.

(*ii*) *Millet*

Coniesta is the dominant genus in millet and its larvae like those *Busseola* enter a dry season diapause. The largest population has been found in a stack of stems but such stacks are uncommon.

DRY SEASON CARRY-OVER OF STEM-BORERS IN GUINEA-CORN AT SAMARU (PREDOMINANTLY *Busseola fusca*) IN STEMS OF TALL KAURA REMAINING IN THE FIELD AFTER HARVEST

The stubbles remaining in the field after harvest also harbour high populations of *Coniesta* and are probablly responsible for the main carry-over through the dry season.

Sorghum Midge Studies.—Observational studies at Samaru show that sorghum midge larvae which were present in guinea-corn spikelets at harvest in November 1955 entered diapause and no emergence was recorded until after the first rains in 1956.

Adult midges began to emerge from diapause in the second week of July but emergence did not reach a peak until mid-August.

The taxonomy of the midges collected during these emergences is being studied and at present it is not clear whether all the midges are in fact *Contarina sorghicola.*

At the time of the early emergences in late July flowering plant of volunteer guinea-corn were present on the Botanist's farm and the early emerging midges oviposited on them.

At the same time no flowering guinea-corn could be found on native farms and attempts to locate sorghum midges breeding on wild grasses and cultivated millets failed to produce any evidence of the existence of hosts other than the cultivated sorghums.

Throughout August there were very few flowering sorghum plants for the midge to breed on and the midge population remained at a very low level at Samaru until late October by which time the main guinea-corn crop had come into flower.

This condition contrasts with previous year when a high population has been present by mid-September, and it is considered that the 1956 growing season at Samaru was abnormal in this respect.

Severe midge damage was experienced in Katsina province during 1956 and the over-all loss of grain in the province has been estimated as 5-10 per cent.

Other figures for losses of grain have already been given in this report in the section dealing with guinea-corn observation plots.

A survey has been devised for the 1957 growing season which should give a more widespread estimate of losses due to the midge.

Life history studies have been complicated by taxonomic problems and cannot be detailed in the present report.

SURVEY OF APHIDS AND ALEYRODIDS IN WEST AFRICA

(V. F. Eastop)

Late March to July 1956 was spent based at Ibadan ; August to September based at Zaria and October to December touring north-east Nigeria. Two weeks were spent in the Gambia in September to October. The Eastern Region of Nigeria and the Southern Cameroons were visited during January and February 1957 and March was spent at Ibadan.

Aphids.—At least 44 species of aphids have been seen from Nigeria and the Cameroons. This number is low compared with those species recorded from East Africa (85), The United Kingdom (420*) or Central Europe (c. 800). North America and the Japan-China areas probably have from 500-800 species each.

The following list contains some of the more important pests or potential pests of economics plants in Nigeria :—

Macrosiphum (*Sitobion*) *spp.*—At least five species of this difficult sub-genus occur in Nigeria. Four feed on grasses and one on an as yet undetermined composite (? *Vernonia sp.*).

Some of these species appear to be undescribed but must be compared with East African material where indigenous species are even more numerous. Many samples were collected at Bamenda and most have not yet been examined, but *M.* (*S.*) *graminis* Takahashi was present.

Pentalonia nigronervosa Coq., the Banana Aphid.—A brown aphid living with ants under the old leaf bases of bananas and related plants which is the vector of bunchy top and Manila hemp virus. It is widespread in the tropics and has been seen from the Gambia, Cameroons and all regions of Nigeria.

Aulacorthum solani (*Kalt*).—Found only at Bamenda where it feeds on many plants. It is a well-known vector of plant virus in Europe.

Myzus persicae (*Sulzer*).—Has been seen from Ibadan, Ago Are, Samaru, Yola, Biu and Bamenda. Feeds on many plants and has been recorded as a vector of more than 100 virus diseases of plants.

Lipaphis erysimi pseudobrassicae Davis.—the "False Cabbage Aphid" and well-known Crucifer pest in tropical and sub-tropical countries. It has been seen from Ibadan, Samaru, Biu and Bamenda.

Toxoptera aurantii (B.d.F.).—A black aphid occurring on citrus, cocoa, tea and many other shrubs. Seen from all regions of Nigeria and the Southern Cameroons.

Toxoptera citricidus (Kirkaldy) (Syn. *Aphis tavaresi* del Guercis).—The Tropical Citrus Aphid, common on citrus (and almost specific to Rutaceae) in the Western and Eastern Regions but not seen from the northern part of the Northern Region. This aphid is the vector of "*Tristeza*" or Quick Decline disease of citrus.

Aphis gossypii Glover.—The Cotton Aphid, feeds on a great variety of plants and is very variable in size and colour. Common everywhere in Nigeria and the Cameroons so far visited. Parasitized specimens have been seen.

Aphis fabae solanella Theobald.—Three specimens from Ibadan and two from Zaria of the *Aphis fabae* group were taken in traps. They appear to be the sub-species *solanella* which normally feeds on *Solanum nigrum*, *Pheum*, *Galium* and probably some other *genera*, but not *Vicia faba*. Common on 'huckleberry', *Solanum nodiflorum*, at Bamenda.

Aphis craccivora Koch.—The groundnut aphid. Also feeds on other legumes and in dry places or times on members of other plant families. It has been seen from all regions of Nigeria and from various places in the Gambia.

Rhopalosiphum maidis (Fitch).—The Maize Aphid. Also feeds on other grasses and cereals. Seen from the Gambia, Cameroons and all regions of Nigeria. Internal hymenopterous parasites have been bred out at Samaru.

Rhopalosiphum rufiabdominalis (Sasaki) (Syn. *Rh. splendens* (Theob.)), the Rice Root Aphid.—Feeds on the roots of many grasses and cereals. Seen from Ibadan, Badeggi and Samaru in Nigeria, near Bama (Northern Cameroons) and Bamenda (Southern Cameroons).

Longiunguis sacchari (Zehntner) (syn. *Aphis sorghi* Theob.).—A cream-coloured aphid forming colonies on the undersides of the lower leaves of sorghum. Very common in all places visited in West Africa below 5,000 feet. In dry weather, sorghum leaves are typically discoloured by the aphid. It is also known as a sugar-cane pest in India, Java and Queensland.

Hysteroneura setariae (Thomas).—An anholocyclic form of an American aphid migrating between *Prunus* and grasses. In West Africa widespread on the secondary host, grasses. Seen from the Gambia, Sierra Leone, Southern Cameroons and all regions of Nigeria. If a name is required for the African anholocyclic form *gregoryi* Eastop is available.

Schizaphis cyperi (v.d.Goot).—A dark-green to black aphid on sedges and sometimes oil palm seedlings. Seen from Ibadan, Kano, Bauchi, Maiduguri in Nigeria.

Cerataphis variabilis H.R.L., the Coconut Aphid.—African records of *C. lataniae* apply to this species. Common at Bamenda, Southern Cameroons and Calabar. Also seen from Ikot-Ekpene and Ibadan.

Tetraneura hirsuta (Baker).—A grass and cereal root aphid seen from Southern Cameroons and all regions of Nigeria.

Geoica lucifuga Zehntner, another grass and cereal root aphid but not as common as *Tetraneura*. Seen only from Ibadan in Nigeria.

As regards economic importance, only *Aphis craccivora* in the Middle Belt as a vector of "rosette" disease of groundnut and *Longiunguis sacchari* in dry seasons on sorghum are regarded as pests. However, two cereal root aphids, *Tetraneura hirsuta* and *Rhopalosiphum* rufiabdominalis, are widespread and may have been overlooked and their damage obscured by that of other pests such as stem-borers and gall midges. There are also several potential agricultural pests such as *Pentalonia nigrenervosa*. *Myzus persicae* and *Lipaphis pseudobrassicae* which may become important with more intensive cultivation of their host plants, particularly under irrigation. At the moment, except in the Middle Belt, climate and the presence of syrphids early in the season and coccinellids later give good aphid control.

The opportunity was taken to collect data on periodicity of aphid flights by means of Moericke insect traps. Several aphids were found to exhibit a marked diurnal periodicity of flight at Ibadan. Observations from mid-April to mid-July showed that *T. citricidus* and *A. gossypii* tend to fly in the morning, *A. nerii* in the afternoon and *P. nigronervosa* in the afternoon and evening. Limited observations at Samaru suggest that seasonal periodicity is more marked in the north. One specimen of *Longiunguis sacchari* was trapped between mid-February and mid-May. In August, 25 were trapped, in September none. There was no trapping in October but from 25th-29th November 130 specimen were taken and an additional 71 in the following five days. This large flight of *L. sacchari* at the end of November was probably common all over the Zaria-Jos-Bauchi-Potiskum-Maiduguri area. There was also a large flight of *Aphis gossypii* in the same region throughout November and a flight of *Tetraneura hirsuta* in October.

Aleyrodids.—The majority of aleyrodids collected are not yet identified. The *Bemisia tabaci* complex was found on many plants. Preliminary experiments showed that the cotton white-fly and the sweet potato white-fly will oviposit on tobacco and that the eggs will hatch and one or two instars are successfully passed.

Other Insects.—In the course of searching for aphids and aleyrodids, many other insects particularly the related sap-sucking families, have been found including thirty or more species of psyllids.

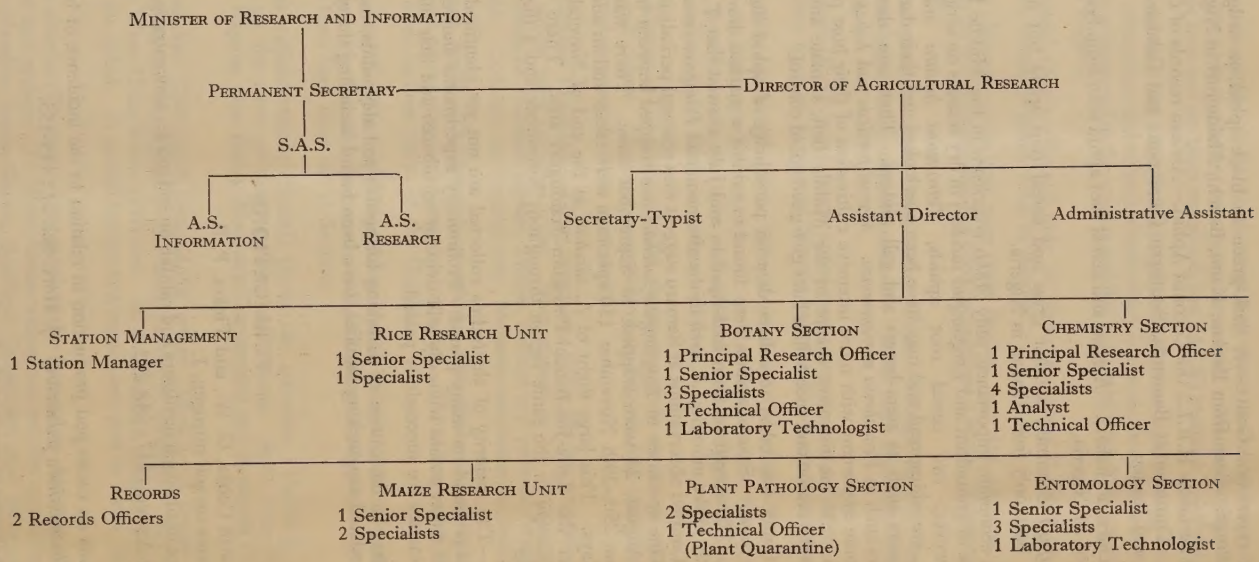
PUBLICATIONS

Bates, J. A. R., with Cooke, G. W., and Tinker, P. B.
1957. Investigations on soil nitrogen. I.—
The influence of nitrogen fertilizers and rainfall on soil nitrate concentrations.
J. Sci. Food Agric., *1957* : 248-252.

Thorold, C. A.
1956. Observations on cacao pod production in relation to the incidence of black-pod disease caused by *Phytophthora palmivora*. J. Hort. Sci. *31* : 149-155.

Thorold, C. A.
1957. A chlorosis disease of cocoa in the Southern Cameroons. J. West Afri. Sci. Ass. *3* : 96-106.

ORGANISATION OF THE FEDERAL DEPARTMENT OF AGRICULTURAL RESEARCH AS AT 31ST MARCH, 1957



24-2-58
23-4-58
3-5-58
15-5-58

427/558/1,500 (55)